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[OFFICIAL NOTICE.]

Respecting the Official Work of the American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION,
SECRETARY'S OFFICE,
530 Broadway, N. Y., Dec. 13, 1904.

To the Members American Gas Light Association: As there seems to be some misunderstanding respecting the standing of the official management of the Association, members will please note that the undersigned is the Secretary of the Association, and that Mr. A. E. Forstall is carrying forward the work of the Practical Class. All correspondence in connection with the Practical Class should therefore be addressed to Mr. A. E. Forstall, 58 William street, and all other matter pertaining to the Association to MR. GEORGE G. RAMSDELL, Secretary, at the above address.

[OFFICIAL NOTICE.]

Wrinkle Department, Ohio Gas Light Association.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF SECRETARY,
DELAWARE, O., Nov. 21, 1904.

The Editor of the Wrinkle Department, Mr. E. E. Eysenbach, General Manager of the Binghamton (N. Y.) Gas Company, earnestly solicits the co-operation of the fraternity for contributions to be presented to the Twenty-first Annual Meeting of the Association, which is to be held at the Hotel Schenley, Pittsburg, Pa., March 15th, 16th and 17th, 1905.

Editor Eysenbach will be pleased to receive contributions not later than February 10th. Work for the good of the cause and send him your "Wrinkles."

T. C. JONES, Secretary.

[OFFICIAL NOTICE.]

Bureau of Information, Ohio Gas Light Association.

CITY OF LINCOLN GAS CO.,
LINCOLN, ILLS., Oct. 10, 1904.

To the Fraternity: At the last meeting of the Ohio Gas Light Association a Bureau of Information was decided upon, the idea of which is to render assistance to members who may have questions coming up or difficultles arising respecting which they would like some help. This Bureau has been established and is now ready for business. A number of co-Editors have been appointed to whom the various questions will be referred. As this is the first Bureau of Information attempted by any Association, it is hoped that the members will take advantage of its opportunities. The co-Editors are as follows:

Distribution.—E. E. Eysenbach and M. E. Malone.
Accounts and Bookkeeping.—D. W. Low and Chas. Ritter.
New Business and Gas Appliances.—Frank D. Moses, Ralph Woodward and F. Cavanagh.
Chemistry.—H. B. Harrop and Clarence Lomax.
Retort House.—Moses Coombs.
Natural Gas.—W. H. Hammon and Geo. W. Barnes.

All questions should be addressed to the Editor, at Lincoln, Ills.

Very truly yours,
H. L. OLDS, Editor Information Bureau.

BRIEFLY TOLD.

A QUEER SITUATION IN THE PUBLIC LIGHTING OF MANHATTAN BOROUGH.—At the present time the legislators, either State or otherwise, who have to do in any sense, unstrained or strained, with the public lighting of the Borough of Manhattan, are quite busy. The mix-up involves all sorts of professional politicians, from the Governor of the State to the President of the Board of Aldermen. The whole trouble on their part (that is the professional and amateur politicians) is that the gas and electric companies of Manhattan have submitted prices for the work of lighting its streets and public buildings which admit of a fair profit to the suppliers. These prices were originally satisfactory to the authorities and contracts thereunder were subsequently made. But the "outsiders," when the documents became binding, concluded that New Yorkers would be better served if their belchings

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were "stored" for analyzation later on. The matter was taken before the courts for adjudication, where it now rests, with the ultimate certainty that the contracts will stand. Meanwhile some of the official signers showed symptoms of fear and joined in a cry for the construction of a plant to be operated on municipal account for the supply of gas and electricity for public use. The legislative halls of Albany and New York hold bills upon bills regarding such measures, where it is best at present to leave them, since commonsense in the end will prevail, likely to the final thought that the cobbler knows a lot about his last. A ridiculous feature so far brought out in this discussion was the editorial plea in one of "Freedom's Journals" that the city now had the nucleus of a gas plant in its works on Blackwell's Island and the ownership of the street lamp posts. Benedicamus Domino! Without any attempt at influencing the legislators who would erect a gas plant in old New York for its public supply, we might suggest to them that the only available spot for construction work on manufacturing plant account in the city is Central Park, which could easily or in due time be hooked up to the verdant pastures of Blackwells Island. Again, meanwhile, it might do to remember that the borough of Manhattan is the best lighted district in the world, whether by means of the highest arc electric light service or its gas service. And this can be learned by any fair interpretation of the lighting statistics of the world at anyone's command to-day.

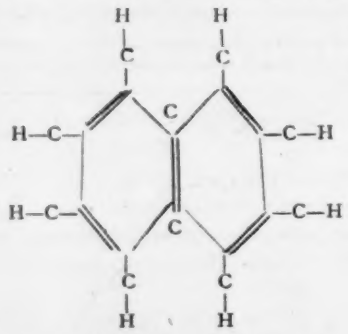
THE STATUS OF THE GAS AND ELECTRIC COMPANY OF BERGEN COUNTY, N. J.—"W. F. R.," Albany, New York, writing under date of the 3rd inst., asks for information respecting the matter named in the heading. Under the circumstances the following, from a recent issue of the Newark (N. J.) *News*, seems a sufficient answer: "The syndicate created by the stockholders of the Gas and Electric Company, of Bergen County, three years ago, to take charge of the finances of that corporation after the serious losses sustained by the Poor and Marquand, Seventh National Bank failure in New York in 1901, was terminated December 28th, the agreement expiring by limitation December 31. By this dissolution more than two-thirds of the $2,000,000 capital stock of the Company will be released by the Bowling Green Trust Company, the depository under the trust, and will return to the control of the original holders. In notifying the stockholders of their resolve not to ask an extension of their powers for 3 more years, as was proposed October 31, the members of the voting trust declare in a circular letter sent out yesterday that the purposes for which it was formed have been fully and successfully accomplished. The committee found the Company in bad shape 3 years ago, with a floating indebtedness of about $200,000. At present, it reports, all the floating debt has been funded on advantageous terms, and the Company has in its treasury ample means to carry out all needed improvements. This has been accomplished without any assessment or charge of any kind on the stockholders. The voting trust, or stockholders' committee, was composed of Edwin Gould, William N. Coler, Jr., William H. Taylor, John C. Eisele, William McKenzie, David St. John, Addison Ely, Frederick B. Schenck and William Nelson Cromwell. Mr. Gould is President of the Bowling Green Trust Company; and Sullivan and Cromwell, who acted as counsel for the committee, act in a similar capacity for that institution. The Bergen County representatives on the committee acknowledge that the prestige of the New York names was a potent factor in saving the Company from a threatened receivership and the accomplishment of its successful resurrection after a practical demise. The dissolution of the voting trust has revived the rumors current some time ago, of the absorption of the Gas and Electric Company, of Bergen County, by the Public Service Corporation. Tentative offers of leasing the properties of the former corporation by the latter have been reported from time to time, but no definite terms have been agreed upon. The voting trust was empowered to lease the various properties on favorable terms or sell the stock of the Company outright at a price not lower than 80 per cent of its par value of $100. Neither of these things has been done, a member of the voting trust declared to-day, and any further offers by the Public Service people will have to be presented to a committee appointed by the stockholders themselves. The Gas and Electric Company, of Bergen County, has had an eventful career. It was organized about 6 years ago by merging the following concerns: The Hackensack Gas and Electric Company, the Ridgewood Gas and Electric Company, the Rutherford and Suburban Gas Company, and the Rutherford, Boiling Springs and Carlstadt Electric Company. The promoter of the merger was Thomas N. McCarter, now president of the Public Service Corporation, and it was the first big consolidation plan of which he was an active agent."

The Naphthaline Question at the Bradford Meeting of the Yorkshire Junior Gas Association.

The *Journal of Gas Lighting* reports that on the afternoon of December 16th the members of this Association gathered in large numbers at the Municipal Technical College, Bradford, to debate the question of "Naphthaline." The President (Mr. W. Cranfield) was in the chair, and the debate was opened by Mr. J. H. Brearley, of Longwood, one of the honorary members of the Association. The Chairman introduced him as one of the most valued of their friends, whose assistance, counsel, and sympathy had been freely extended at all the stages in the development of the Association, and to whom they were greatly indebted.

Mr. Brearley opened the debate with the following remarks. Naphthaline is a hydrocarbon closely associated with the benzol series, for in the process of carbonization it is probable that two atomic rings of benzol are united in such a manner that two carbon atoms of one ring do service for both rings according to the following equation:

$$C_6H_6 + C_6H_6 - 2C - 4H = C_{10}H_8$$



In the molecule of a hydrocarbon, it is generally true that the less the number of carbon atoms and the greater the number of hydrogen atoms the more volatile it is. Thus marsh gas (CH_4) and ethane (C_2H_6) are gases; propane and butane (C_3H_8 and C_4H_{10}) are very volatile liquids; and so on. Benzol and its homologues, as you know, are volatile liquids, while naphthaline and anthracene are crystalline solids.

Naphthaline is fusible at 79.2° C or 174.6° F., and boils at 217° C. or 422.6° F., without decomposition. It is not decomposed at a red heat; and not until the high temperature of its flame is reached is decomposition effected, and that only with the assistance of the oxygen of the air. The formation of naphthaline in the process of carbonization is pretty well understood. It is generally conceded that the introduction of high temperatures frequently, though not necessarily always, heralds the trouble of naphthaline deposits. This is due to so much naphthaline being produced in the crude gas that a portion of it often escapes being carried down in the liquid products of condensation, and this ultimately forms a solid, sometimes in the purifier connections, occasionally at the gasholder inlet or outlet pipes, but more frequently in the mains and services of the district. The same thing applies to the carbonization of gas oil in the manufacture of carburetted water gas. Troubles with naphthaline are much more likely to exist when the oil is split up at a high temperature as against a low one. The vapor tension of naphthaline, as you will be aware, is very high; and to this, together with the property of changing from the vaporous to the solid state without passing through the liquid condition, has been fittingly attributed the origin of naphthaline troubles.

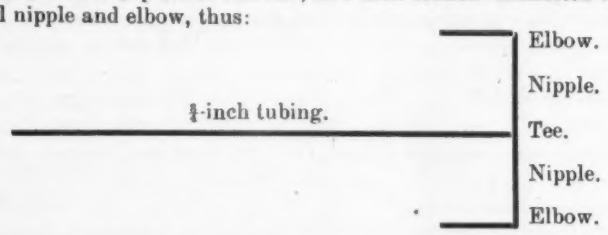
Those seniors who have been troubled with naphthaline know too well the remedies they must apply to remove deposits. These, however, may not be too familiar to you; and the following extracts from communications which I received from other engineers may be of interest: "The principal points of stoppages are in our scrubbers and in the inlet and outlet of the gasholder on the works. An increase of pressure at the affected point indicates coming trouble. When the stoppage is in the scrubbers, there is nothing for it but shutting off the affected scrubber and taking out and scraping every board. Our first scrubber has been cleaned out twice in 4 years, and the second once; and each cleaning has yielded quite a cartload of naphthaline. When a stoppage occurs in the inlet or the outlet of the gasholder, we adopt a system called 'plunging,' which is as follows: The flange is taken off the inlet or outlet pipe, and the latter is then filled with water. To a long pole sacks are fastened at one end, so that it will just fit the pipe, and to the other end of the pole half-a-dozen ropes are fastened. The end with the sacks is inserted in the pipe, and a man takes hold of each of the six ropes at the other end, which, of course, is in the air. They pull, and

the pole is forced down the pipe, pushing the water forward into the holder—the naphthaline being carried with it. This repeated two or three times clears the pipe."

The influence of atmospheric changes, so ably dealt with by Mr. William Young, in his paper presented to the Gas Institute in 1900, is technically illustrated by particulurs which I get from the same engineer. The service to a fishmonger's shop passed through his cold storage cellar, with the result that every few days the service beyond was completely blocked with naphthaline. Ultimately a larger service was put in and the trouble apparently ended.

It is pretty well known that before naphthaline troubles are experienced, the gas must come in contact with cold surfaces, scrubbers, exposed washers, open purifiers, and the like. In a neighboring district to ours, the only place where naphthaline trouble is experienced is at a point about a mile beyond a length of main that crosses a stream. The sudden cooling at this point brings down the naphthaline, and this is carried in the stream of gas to the point where obstruction is most easily set up.

At another works the most acute point of the trouble was the inlet of the largest gosholder. The remedy applied here was to fill up the siphon with very hot water. Then two lengths of ¾-inch piping were screwed together, with a T-piece at one end, and each branch connected with a barrel nipple and elbow, thus:



Round this sacks were wrapped to fit tightly the 9-inch pipe, and the result was pretty much the same as in the first instance referred to, viz., that the naphthaline which was not forced into the holder was subsequently pumped from the siphon. One engineer in the South attempted to clear naphthaline from his gasholder connections with the aid of steam. The only obvious result was that he knew more abont naphthaline after than he did before he attempted this remedy. The naphthaline was converted into a solid mass instead of flocculent crystals, and was ultimately removed with iron bars. The use of crude naphtha is largely resorted to for clearing services or mains where the force pump is impotent.

Of course, the methods of clearing naphthaline referred to are, figuratively speaking, as old as the hills in districts where troubles of this nature are pretty frequent. But the West Riding is not one of them, and it occurred to me that they would not be devoid of interest to juniors who may some day be faced for the first time with a stoppage through deposition. Moreover, information as to this class of remedial measures does not receive that frequent publication that is accorded to what may perhaps be described as remedies of the preventive class.

You have probably assimilated such knowledge as is at present available as to what goes on when coal is distilled. Much of that which takes place in the retort rests upon the basis, often slender, of hypothesis. We are pretty sure, however, that synthesis and decomposition proceed side by side; and it has been proved that the carbonizing heat is an important factor in the quantity of benzol and naphthaline produced. Generally speaking, with low heats the yield of benzol is high and that of naphthaline low; high heats have the reverse effect. While these increase the quantity of naphthaline diffused in the gas, troubles from naphthaline by no means follow as a natural sequence. If it were so, external curative agencies would be required at all works where high heats are the rule. Some works are, however, entirely free from trouble, even though working with high carbonizing temperatures. The time will probably come when discussion will not be most acute as to which particular solvent is best with which to wash the gas when introduced externally, but which process of manufacture (bearing in mind economical production) will insure freedom from naphthaline troubles, and render superflous solvents introduced externally. This is no new idea. Many engineers still hold that the secret of lasting success lies in the method of condensation. My sympathies are with this view, as it seems to accord with my own experience.

It is no doubt paradoxical to speak of experience when, as a matter of fact, during 16 years spent in the gas industry, I have never had experience of naphthaline in its "Mafficking" moods. These years have been about equally divided between two works, and during the whole of the time not a crystal too many has been formed, either on the works or in the mains and sorvices. Such an experience places one, with respect to naphthaline, in a similar position to that occupied by a certain eminent journalist with respect to the theater which he recently visited for the first time at the age of 54. If my experience of naphthaline rampant is similarly deferred, I shall have due cause for self congratulation. The journalist is now giving his impressions of the theater, and it is held that he will be able to criticize and describe impartially what he sees, since his mind is unbiased by previous association. This argument applies with equal force to our subject matter. There can be little doubt that association with sectionized research for naphthaline remedies, particularly if it meets with some measure of success in its early stages, impairs the perspective with which other forms of research are viewed. One need not go into ancient history for illustrations of this.

While dealing more particularly with naphthaline as affected by observations and results at Longwood, experiments and tests which I intended to bring before you are in an incomplete stage, and therefore not ready for publication to-day. The scope of my remarks, consequently, is much more limited than I had originally intended. Six years ago regenerative furnaces were introduced, the furnaces previously employed being of the generator type. Higher heats were obtained, and we have tried to realize the ideal set up by Mr. Charles Hunt, that "the best heat for ordinary working is the lowest that will thoroughly carbonize in the allotted time, the stopped pipes with high heats causing loss beyond the gain by the high temperatures." Incidentally it may be remarked that we have no stopped pipes. The deposit which forms at the bottom of the ascension pipes is cleared at each charging by the stoker's auger, and this is the only deposit that needs attention. Directly after the regenerative furnaces were introduced, the distiller of our tar pointed out that there was a marked variation in its composition. The quantity of light oils was considerably less, while that of naphthaline was nearly doubled. In short, the naphthaline was present in the tar in greater proportion than in any other of about 20 tars distilled. This set the writer thinking. If the tar from the Longwood works contained more naphthaline than any other, then obviously we dissolved out more from the gas, and as we were never troubled with naphthaline deposits, it indicated at least the desirability of research. Tests properly carried out on works entirely free from naphthaline troubles ought to throw quite as much light on the solution of this problem as others conducted at works where troubles are experienced.

Incidentally a reference to the carbonizing results may appropriately be made here. The coal employed consists of gas nuts, unscreened coal and gas slack, in the proportions 3, 5 and 2. Working over 12 months with these proportions gave an average yield of 10,053 cubic feet. The retorts are 9 feet long and 21 inches by 15 inches in diameter, and they are hand charged. It will at once be seen, therefore, that fairly high heats are the rule. With screened coal we should expect to get a yield of upwards of 11,000 cubic feet, against the yield with the class of coal now used. A recent analysis of tar from the Longwood works, based on the distillation of 12 tons (working scale), was as follows:

Products per Ton of Coal Carbonized.

		Cwt.	Qrs.	Lbs.
8 gallons of	5° Twaddel ammoniacal liquor (2 pr. ct.)	0	3	0
5 "	crude naphtha	0	1	14
8 "	lightoils	0	3	12
80 "	creosote	7	2	0
Pitch		10	2	0
	Total	20	0	0

The 8 gallons of light oil yielded: ½ gallon of 90's benzol, 2 gallons of 50's benzol, 1 gallon of carbolic acid and 4½ gallons of creosote. The 84½ gallons of creosote, on further distillation, gave 5 cwt. 2 qrs. of naphthaline pressed. Longwood tar yields far more naphthaline in winter than summer, the quantity per ton in the hot summer months averaging 3 cwt., against 5½ cwt. in winter. It is apparent, therefore, that to some extent, at any rate, naphthaline remains permanently in the gas in the summer, though small portions may be arrested by the purifiers.

This all goes to show how important is the influence of condensation, and herein appears to lie the only lasting solution of the problem. The condensers at Longwood are atmospheric and of the annular type. They are 4 in number and each is 29 feet high, the inner tube being 2 feet 9 inches and the outer tube 4 feet in diameter. The maximum day's make is 480,000, and the minimum day's 144,000 cubic feet, or 20,000 and 6,000 cubic feet per hour respectively. The gas passes through the condensers in 7.68 minutes in summer and 2.30 minutes in winter. There is a condensing surface of 2,460 square feet, but preceding the condensers is a foul main 212 feet long and 12 inches in diameter. The total condensing area—that is, condensers and foul main combined—is

3,126 square feet, which is equal to 156 square feet per 1,000 cubic feet on the hourly winter's make, and 521 square feet on the hourly make in the summer. There are no less than 7 right angle bends in the foul main before it reaches the condensers. In winter the gas passes through it at the rate of 7 feet per second, and in summer at a speed of 2 feet 2 inches per second. It is obvious, with these speeds, that the bends will act as baffles, and at each turn of the pipe an eddying motion will be set up that will throw many of the tarry globules together and bring them down—performing in a lesser degree the work of a tar extractor. At 69 feet from the inlet to the condensers the foul main is deflected upwards from the horizontal to the vertical, and at this point a tar take-off is fixed.

The consideration of the problem of why we are not troubled with naphthaline deposits does not appear to be made any simpler by a perusal of the figures showing the growth in the quantity of gas made during the last few years with identically the same condensing, scrubbing and purifying plant. Here are the returns of the make of gas per annum and the maximum quantity made in one day for the years 1895 to 1903 inclusive:

Year.	Gas Made. Cubic Feet.	Maximum Day's Make. Cubic Feet.
1895	44,944,100	253,000
1896	47,043,800	251,300
1897	50,089,600	264,800
1898	56,290,100	268,200
1899	63,576,800	394,000
1900	66,238,200	339,900
1901	80,091,900	466,500
1902	89,060,600	462,900
1903	94,502,200	479,800

It will thus be seen that the relation between the lowest and the highest maximum day's make in this table is as 100 to 191, or practically a doubling of the duty imposed on the same plant.

About 3 years ago we changed from a type of anti-dip, which was far from satisfactory, to a liquor seal with a separate regulating box to each bed. At the same time we made an alteration in the tar take-off arrangements. Hitherto all the tar had travelled with the gas in the foul main for a distance of 143 feet, at which point, as already stated, a tar take-off is fixed. The alteration we made was to remove direct from the hydraulic main the tar produced by one-half the beds, leaving that made by the other half to travel with the gas as before. This is mentioned because under both arrangements we have had complete immunity from naphthaline troubles. This applies also to benzol enrichment, which, after being at work for something like 5 years, was discarded about 2 years ago.

One of the most important points arrived at by two American investigators—Messrs. White and Ball—is that the purifier may exert a very important influence as a balance wheel in controlling irregularities of naphthaline passing forward from the scrubbing plant. They proved that the purifiers will store up a very considerable quantity of naphthaline, and subsequently slowly give it back to a gas low in this constituent; receiving more in turn from a richer gas. They made numerous tests to support this, and coincidently it may be mentioned with purifiers the same size as those now in use at Longwood.

So far as these remarks and particulars apply to Longwood, they are given not so much for the actual information they contain as for the ideas they suggest. For us, at all events, it has mapped out a course which will be pursued somewhat on the following lines: (1) To test in varying seasons the finished gas for grains of naphthaline and for the vapors of absorbent liquids. (2) To test the gas after passing the scrubbing plant—viz., at the inlet of the purifiers—for grains of naphthaline. (3) To test it also at the inlet of the scrubbing plant. (4) To observe by tests the proportions of solvents—that is, oils distilling over at from about 130° C. to 215° C.—and naphthaline in the tar as it runs off from various points between the hydraulic main and the outlet of the condensers. (5) To test the crude gas at similar points for (*a*) vapors of solvent liquids and (*b*) naphthaline. Other tests may follow; but this is a fair list to be going on with. I had hoped to reach this stage before appearing before you; but it has been impossible to get through with them.

In carrying out the tests, we shall be faced with the difficulty that a reliable method has not yet been evolved for testing for naphthaline crude gas laden with tar fog. The apparatus devised by Messrs. Colman and Smith produces satisfactory results with crude gas after the tarry particles have been removed; but it will not be satisfactory for testing gas previous to condensation. The minute globules of tar held in suspension will contain a proportion of naphthaline which has passed from the gaseous condition; and whether a method can be evolved for separating these without disturbing the normal composition of the gas at the point of test, remains to be seen. The American investigators previously referred to devised a method of arriving at the amount of mechanically suspended tar, the quantity of naphthaline in it, and the proportion present as vapor in the gas. Their methods are fully described in the *Journal of Gas Lighting* for Oct. 25 and Nov. 1 last (pp. 252, 323); but, speaking without having put them to practical application, they seem to admit very largely the liability of personal error. This would preclude any but chemists of long practical training and skill from arriving at even approximately reliable results. If an apparatus can be devised which will admit of the separation of the tarry globules from the gas without causing the latter to pass through the separated tar, fairly correct results may be arrived at. How separation is to be effected, however, without altering the composition of the gas (*minus* the tar fog), and without causing the gas to pass through the tar which is being separated, is something which I fear will not be attained. Owing to the variation in the charges, the condition of the coal used, etc., a large number of tests will be required before reasonable deductions can be made therefrom.

Since writing the foregoing, I have been able te peruse the report which the Naphthaline Sub-Committee have just presented to the Southern District Association. I am glad to find that the work of that Committee is proceeding very much on the lines which my own reflections lead me to conclude are the correct ones. The Committee say in their report that they believe it is possible, by submitting the gas to treatment in a condenser designed to embody certain principles indicated by the investigation so far as it has gone, to eliminate naphthaline to such an extent as to prevent further trouble from it. When it is considered that so many works, like our own, are not troubled with naphthaline year in year out, even though, as a vapor, it issues from the retort in large quantities, this certainly appears to be the most rational method of facing the problem, since, to quote from the Southern District Association report, it would be "automatic and inexpensive."

Discussion,

Mr. P. Parrish (Dewsbury) spoke of his practical experiences in the South of England, where one portion of a works main was completely filled with naphthaline. He fitted into the foul main a rectangular box with baffle-plates in it, in order that the increased friction might induce deposition of naphthaline; extended the condensing area, which was greatly deficient: and rearranged the horizontal pipe condensers so that their tar should flow in the contrary direction to the gas. So far these modifications had been highly successful. He should be glad to know Mr. Brearley's experience of the standard test—whether he found the amount of naphthaline indicated by weighing the precipitated naphthaline picrate and that obtained by titrating the picric acid to agree with each other. Personally he did not find them satisfactorily near together. He wished to be informed as to what statistics existed regarding the vapor pressure of naphthaline; his experiments led him to think that gases could be super-saturated with it, as he often found it present in greater excess than theoretically it should be in the gases at the given temperatures.

Mr. J. F. Smith (Halifax), in answering the last speaker, said that a state something akin to super-saturation undoubtedly existed; but while the maximum amount of naphthaline that could be held as a vapor in any gas was definite for any given temperature, some could also be retained mechanically. Sudden cooling would produce condensation; but the deposition of the separated particles would start slowly. As regarded the inquiry about the agreement of the amount of naphthaline picrate weighed with the result of titrating the picric acid, he could emphatically say that they would agree if certain details were observed, and the published instructions carried out to the letter. In the work upon the development of this test in which he had been engaged in conjunction with Dr. Colman, the reliability of the method has been repeatedly proved. The all important precautions were: Frequent shaking during the first hour of cooling, so as to bring down all naphthaline from the sides of the vacuum bottle, and the avoidance of any excess of liquid in washing out the bottles. He should be glad to know how far apart Mr. Parrish's estimations were in the two methods mentioned.

Mr. Parrish said 1.5 per cent.

Mr. Smith congratulated Mr. Parrish on his success, and assured him that such a result was more exact than would usually be found, inasmuch as the authors of the test only claimed accuracy to within 1 in 30—*i.e.*, 3⅓ per cent. He thought Mr. Brearley was taking too limited or else too rosy a view when he spoke of the West Riding's freedom from

naphthaline trouble. He knew of it least two reports on the subject dated in the early sixties. The reference to it in the classic writings of the Rev. W. R. Bowditch, Vicar of St. Andrew's, Wakefield, suggested it was an old enemy in that town. When he first entered gas works eighteen years ago, in Sheffield, they were troubled with it, and the engineer of one works near Mr. Brearley's frankly owned to being plagued with it, and deemed himself almost the only honest engineer for being so candid. Mr. Brearley's introduction might lead his listeners to an erroneously limited conception of the origin of naphthaline, for it could be produced in the decomposition of benzine by heat—

$$\underset{\text{Benzene.}}{2C_6H_6} = C + \underset{\text{Methane.}}{CH_4} + \underset{\text{Naphthaline}}{C_{10}H_8}$$

This view was supported by the known production of scurf, and of methane at high carbonization heats, when naphthaline also was formed. Bertholet and Hanchütz had also produced it from toluene and from acteylene—

$$\underset{\text{Toluene.}}{4C_7H_8} = 3C_6H_6 + C_{10}H_8 + 3H_2$$

$$\underset{\text{Acetylene.}}{5C_2H_2} = C_{10}H_8 + H_2$$

Probably much was also produced from the benzene homologues; the following equation being similar to that which Kraemer found on investigating the Dinsmore process—

$$4C_6H_6 + 2C_7H_8 + \underset{\text{Xylene.}}{2C_8H_{10}} + \underset{\substack{\text{Coal Tar.}\\\text{Cumene.}}}{2C_9H_{12}}$$

$$= \underset{\substack{\text{Naphthaline}\\\text{hydride.}}}{2(C_6H_8)_2} + 3C_{10}H_8 + \underset{\substack{\text{Anthra-}\\\text{cine.}}}{C_{14}H_{10}} + 2CH_4 + 2C_2H_2 + 9H_2 + C_2$$

Naphthaline also reacted with acetylene, yielding anthracine, for the gas works production of which this supplied one theory—

$$C_{10}H_8 + 2C_2H_2 = C_{14}H_{10}$$

He agreed with Mr. Brearley's remarks on the economical temperature of carbonization; but some of them were unable to observe it to any considerable degree, because of the class of coal used, out of which they must get the gas. The economical temperature was not always that of the maximum make, but of the maximum candle power per ton. This latter would often involve a richer gas than they were instructed to supply; so the heat of the retorts was raised, and more gas was made of a lower grade. In this case they were not getting the best out of the coal, nor were they aiming at it. There was a difference in the coals in regard to economical temperature. In the remarks made by Mr. Charles Hunt which had been quoted, he estimated that this temperature, would generally be about 1,650° F., as measured by a Siemens water pyrometer, but stated that he did not mean that the coal should necessarily be distilled at that temperature. Another factor entering into the case was the different sizes of coal. Professor Mills, of Glasgow, had shown that, with coal in pieces 3.75 millimetres wide, he got 9,437 cubic feet of gas per ton; but that with the same coal carbonized under identical conditions, but with pieces 0.375 mm. wide he only got 0,280 cubic feet per ton, and even this quantity came off but slowly. As one must charge and draw at definite intervals, something had to be sacrificed of theoretical considerations. With a fairly large coal, one could perhaps maintain the economical temperature; but at that same temperature the time would be too short for slack, so a higher one then became neccessary. When a charge of such small coal was drawn, a core of black coal was generally found in the center, somewhat nearer the bottom than the top of the layer. Carbonization thus proceeded from the outside towards the center; and more by radiant heat from the top and sides than by transmitted heat from the floor of the retort. The gas from the central parts thus had to pass through incandescent fuel, and its benzol became decomposed. Thus one found more naphthaline resulting from carbonization of small than of large coal. [Mr. Smith then dealt with the estimation of naphthaline in hot gas, and sketched on the blackboard an adoption of the usual test apparatus, which he said should be able to yield the desired result.] He questioned the need of knowing how much naphthaline existed in the gas and tar separately, and would be evident, he thought, from the consideration of the physical chemistry involved. Condensation was not simply cooling the gas to a given temperature, but should be a scientifically conducted process for also retaining as many of the illuminants as possible, and selectively removing some other hydrocarbons. People were inclined to regard it too simply. It should be looked at from two aspects—first as a process of fractional condensation, and secondly, as saturating a gas with a hydrocarbon vapor (*i.e.*, naphthaline). Many of the vapor tensions concerned had not been fully determined; but one could still discuss them by general formulæ. Vapor pressure multiplied by density equalled the weight of a vaporized substance in a gas. Now with two non-miscible substances, which would not dissolve one another of vapor pressure p and p^1 and densities d and d^1, these existed together in a gas in tne proportion of $pd : p^1d^1$. Regnault investigated this with naphthaline and water (among other substances). Incidentally, he might say, the question of the condensation of water vapor had something at least to do with naphthaline deposits, in spite of recent statements to the contrary. In the case of coal gas and naphthaline, however, they were dealing with vaporized substances which did mix and dissolve each other; and the vapor tension of a vapor was lowered by the introduction of a solvent. For example, pitch could take out benzol, as would also naphthaline, and reduce its vapor tension; and in coke ovens, heavy oil was used to extract benzol from the gas produced. A striking instance of the action of solvents in reducing vapor tension was the case of formic acid and water, where the total vapor tension was less than that of either of the substances separately. In the case of miscible liquids, the rule previously quoted needed the insertion of a new factor—a constant (K), to be determined by experiment, for each new combination of substances which should represent this new condition in the case, so that one could state the rule that the vapors present were as $KP : KP^1$. Now, in the gas retort all the volatile substances were in the form of vapor (say at temperature t) and eventually were cooled to temperature t^1; so introducing still another factor—the molecular percentage.

Vapors present at t = K in per cent. P: K in per cent. P^1
" " t^1 = K " P: K " P^1

Subtracting $t - t^1$ = K in per cent. P: K in per cent. P^1

This was the part thrown down as tar. Too often our methods of condensation succeeded in removing illuminants and also valuable solvents. Bowditch long ago saw that the lighter hydrocarbons would go forward with the gas, if the heavy tar was quickly removed from contact with the gas. This reduced the constant K to a negligible quantity as regards the solvent action of the heavy hydrocarbons, and enabled the light oils—the naphthaline solvents—to go forward. This was the aim of Dr. Colman's cyclone arrangements and of Mr. Everett's (of Ilkley) screens for tar fog. Finally, coming to the second phase of condensation (as previously mentioned), it might often be found that the gas at the condenser outlet had very little naphthaline—say, 4 grains per 100 cubic feet—and yet considerable trouble might exist from stoppages, because this clean gas proceeded along mains with heavy deposits in them, from which naphthaline would be taken up by the gas —*i.e.*, it would exert its vapor pressure pure and simple.

Mr. W. N. Booth (Halifax) thought that Mr. Brearley must not too readily accept the tar distiller's statement that his tar contained 5¼ cwt. of naphthaline per ton in the summer, as against 3 cwt. in the winter, or, at least, he must not conclude that the 2¼ cwt. difference remained permanently in the gas in summer. The following figures seemed to reduce that supposition to an absurdity. At 68° F. gas was saturated with 27 grains per 100 cubic feet; and at 35° F. it was saturated with 5 grains per 100 cubic feet. Now, 20 tons of coal gave, roughly, 1 ton of tar—

i.e., 200,000 cubic feet of gas were produced to every ton of tar.
2¼ cwts. = 1.960,000 grains.
i.e., 1,960,000 grains naphthaline carried by 200,000 cubic feet, or 980 grains per 100 cubic feet,

which was 36 times as much as would saturate it at 68° F.

Mr. J. Bottomley (Milnrow) thanked Mr. Brearley for his descriptions of practical methods. It was valuable to know how naphthaline was produced, but valuable likewise to know how to remove it. Personally, he had no naphthaline trouble, though his tar was rich in it. He had seen many instances which clearly indicated the powerful influence of sudden changes of temperature. At one seaside town, where strong cool winds often prevailed along with strong direct sunshine, he had frequently found one side of a street with nearly every service pipe blocked, while no such trouble occurred on the other and sunny side.

Mr. J. H. Hill (York) owned to being troubled all the year round at both the York works, especially in winter. The tar from one works was exceptionally rich in naphthaline, more so than the other, where, however, they eventually found their condensers nearly blocked up. They had tried the Sheffield plan of condensing only to a fairly high temperature, but with similar apparent lack of success.

The President, in speaking briefly to close the discussion, said that, after the carrying out of the comprehensive scheme of tests outlined in Mr. Brearley's remarks, he knew he should be able to rely on even a still more enthusiastic and convinced support from that gentleman of the scheme outlined in his Presidential Address. Such tests were just

the kind of work that few of the younger men had the opportunity of learning to perform, but which were absolutely necessary in any really scientific attempt to deal with the problems arising from naphthaline. The more discussions he heard and read on the present question, the more firmly was he convinced that very much of the past and present muddle arose from incomplete observation and non-comparable conditions. This vitiated many of the statistics offered, and readily explained why a process successful in one place seemed a failure at others. One heard of success attending (say) a temperature higher than usual at the condenser outlet; and it was promptly used at other works —probably oblivious of how far other unmentioned conditions were vital and perhaps predominant factors in the situation. This led to another consideration. They urgently needed not only the severe application of the principles of pure chemistry and physics to their gas problems, but also of logic, which really was systematized common sense. One of the commonest pitfalls was the confusing of the *post hoc* with the *propter hoc*. Because A followed B, it was not necessarily due to and consequent on B. This was a platitude, and should need no laboring; but it cropped up abundantly, and he had come across several naphthaline devices—not to mention those in other departments of gas practice—which were quack remedies of the *post hoc* type, whose full bearing and explanation had not been thought out. No noteworthy progress ever followed such practice, and but seldom would temporary and individual relief follow from it.

Mr. Brearley, in replying, expressed his pleasure at the vigorous and pointed discussion that his remarks had led up to, and said he felt that the sense of obligation was mutual. He had hoped to provoke a discussion that would enable him to go home knowing more of naphthaline than when he came; and he was satisfied with his success in this direction. He only accepted honorary membership of the Association on the understanding that he was to do something for the members. Replying to an inquiry put by Mr. Whitaker (of Wakefield), he said that the temperature at his condenser outlet was about 50° F. in winter and 70° F. in summer, and ranged between the two. He had not found any pressing necessity to regulate it in any other way or to any further extent. In the main, he must adhere to his reference to West Riding freedom from naphthaline, and ventured to say that an inquiry among the members present would largely support his contention. Anyhow, the contrast with what existed in the South of England was very striking. He highly appreciated Mr. Everett's tar separator, and thought the results obtained very striking, and its promise bright. Even if naphthaline began to appear in larger quantities in the tar, etc., on the introduction of higher heats, without causing immediate trouble in the district, he thought Mr. Smith over-estimated the length of time that might elapse between cause and effect. He did not believe his successor would in that way have to suffer from his predecessor. He thought the statement as to the "sins of the seniors being visited upon the juniors to the third and the fourth generation," was much overdrawn. As regarded the apparent absurdity of the naphthaline proportions in his summer and winter tar, he should now think the explanation to be that the distiller had failed to account for all the naphthaline in the thinner creosote oil of summer time. He would remind them that the juniors had more time for practical laboratory investigation than the seniors, who would gladly encourage them in any research work which did not unduly interfere with their routine duties. In Yorkshire, out of 95 works, 74 made less than 100,000,000 cubic feet per year; therefore, few could keep a trained chemist, even if the supply of such gentlemen would be sufficient to meet a greater demand. He expected that before 25 years had elapsed, practically every works of a greater annual make than 50,000,000 cubic feet would have its own chemist.

In proposing a vote of thanks to Mr. Brearley, which was afterwards carried enthusiastically, Mr. E. Sutcliffe (Birkshall, Bradford) spoke of Bradford's immunity from naphthaline trouble except for one year (1893), when, owing to the great coal strike, their ordinary Yorkshire coals had to be replaced by Durham coals. The seconder, Mr. E. Benn (Heckmondwike), spoke of the rare occurrence of trouble in his district. When it did occur, it was at old cottages, in the service pipe, which had to be carried some feet up the outside walls.

We believe we can authoritatively state that, in so far as the gas interests are concerned, there is no truth in the rumor that the interests and properties of the Cleveland Gas Light and Coke Company, the Peoples Gas Light and Coke Company, the Cleveland Electric Illuminating Company and the Cleveland Electric Railway Company, all of Cleveland, O., are to be merged.

Notes on Power Production.

By William McClellan, Ph.D.

Some time ago a very prominent engineer said that he was not willing to install a large steam engine plant, or even one of steam turbines, at the present time, because it was very likely that before he could get it started he would be sorry that he had not put in gas engines, so quickly is the latter type developing. Yet, even in face of the fact that steam turbine contracts are being made nearly every day, and reputable companies are ready to install gas engines under guarantee, there are some engineers who refuse to consider any type except the steam engine. When one looks at the enormous investments now being made in steam engines at probably the largest steam power house in the world (the Interborough power house in New York), it is evident that there is some reason for this attitude, though if the decision in regard to this station were to be made to-day, it is possible that it might be different.

Amid the more or less vigorous discussion that goes on at intervals, one finds it rather hard to keep a well balanced mind and reserve judgment until the evidence is all in. The chief difficulty, of course, is the difference in the amounts of information that we have in relation to the various sources of power and their applications. Of the steam engine we know much, of the steam turbine much less, and of gas and oil engines real knowledge (for most of us) is very meager indeed, except of the smaller sizes. In the second place our knowledge of steam is largely first hand, which is not true usually for gas and oil. It may be well therefore to sum up in an unbiased way what may be said for the various types in the light of our present knowledge. It should be understood that the writer has in mind plants of not less than 1,000-horse power, since the question is a very different one to the small and the large user.

We may classify prime movers as follows:

Steam: (1) Engine. (2) Turbine.
Gas: (3) Engine. (4) Turbine.
Oil: (5) Engine, explosion type. (6) Engine, Diesel type.
Water: (7) Turbine.

Of these we shall discuss only the first three, since the gas turbine and the oil engine lack development, particularly in the large sizes, and the water turbine depends too much upon local conditions and circumstances. The gas turbine is theoretically the ideal prime mover, and when (if possible at all) it is put in practical shape, it will take first place. The Diesel engine as far as it has been developed, that is to 225-horse power, makes a remarkably fine showing. How it will succeed in holding its own is still a matter of time.

It seems proper to consider a prime mover from three standpoints: Reliability, Regulation and Cost, and we shall do so in this paper, and in this order of importance, also, for we must assume that an engineer is willing to pay for reliability and for as much regulation as is necessary.

Reliability.—The reliability of any machine depends equally on two things, proper design and proper operation. So far as design is concerned it is probable that all our types are equally reliable. A faulty design shows itself either in parts failing to function as expected or in breaking. Accidental breaking, except frequent breaking of the same part, will always be possible even in the old reliable steam engine. For example, the writer has seen two Corliss valve cranks break on different engines during the last year and temporarily throw the engines out of service, yet no person would call the Corliss engine unreliable because such accidents happen at times.

The steam turbine, owing to its small number of parts, small friction surface, and absence of reciprocating motion, is extremely reliable. Were it not for the close proximity of high temperatures and comparatively high speed bearings, the reliability would be even greater. This proximity means that the bearing is normally very near to a danger point, especially in the smaller and more compact sizes. In one make of turbine where some of the parts have very great speed, the high speed bearing can never be touched by the hand while running, and the slightest failure in the cleanliness, quality, or quantity of the oil means a burn out. Engineers have finally agreed that the famous step bearing of the Curtis turbine, which aroused so much controversy and misgiving, is quite good design, and recent developments seem to indicate that in the near future oil lubrication will be a thing of the past in connection with this type.

The gas engine presents many new difficulties in design, which were not overcome in early engines. Gas engine cylinders not long ago often cracked on account of the excessive temperatures and pressures, but we almost never hear of this now. The igniter will always be a source of

trouble, and for this reason we shall never cease looking for a practical gas turbine, or slow burning type of engine, until we find it. This will come, just as the steam turbine has come. Yet duplicate igniters and proper inspection have done away with the difficulty of ignition entirely. These are the chief troubles that have been observed and it does not seem to be too much to say that with them out of the way the engine is reliable, that is, with proper attention it will not fail suddenly and cause a shut down.

But here is the *sine qua non*—proper operation. There is a small army of men who understand all the details of steam operations and are able to detect the first warnings of trouble before it becomes serious. Less than a month ago a prominent operating engineer complained of some noisy steam turbine pumps because the noise prevented his engineers from hearing the engines talk; "an engineer prevents trouble by using his ears," he said, and he was right. Moreover through years of experience these men have learned a thousand tricks and makeshifts that help them out of tight places. Many of these will serve equally well with the gas engine, but more will have to be learned. The running engineer, usually of scanty education, having learned almost everything by experience, cannot be taught in a day that clean gas is just as important as dry steam, or even more so; that cooling water is not a mere help as it is in an engine bearing but an absolute necessity in a gas engine; and that an igniter like everything else works till it breaks down, but breaks down sooner than some other parts.

The writer considers a gas engine installation to be thoroughly reliable, but he would be very careful in the selection of his men and would not leave the engines entirely in their hands until he had them well educated. Europe has passed far ahead of us in gas engine practice and we hear no talk of failure. The well known faculty of European engineers for careful operation is responsible for this, for no one will deny that we have several makes of gas engines in this country that are as good as or better than any made abroad. Many persons are claiming, on the other hand, that a cheaper attendance will be possible in gas engine practice. If they mean by this a smaller number of men they are undoubtedly right, owing to the smaller number of auxiliaries, but if they mean less intelligent men they are greatly mistaken.

It is more nearly fair to consider the two plants rather than the engines alone. Our steam plant consists of a boiler with a large number of joints under high pressure; a long line of suspended piping under like pressure, and subject to severe expansion strains; a group of pumps, traps, condensers, valves, in conjunction with a complicated exhaust, with which it takes a man a long time to get acquainted sufficiently to do the right thing at the right time. In the gas engine plant we have a producer and holder with little pressure; a low pressure pipe line; no auxiliaries except a starting outfit and a very simple exhaust; a plant with large possibilities for storage of power at low cost, and so simple indeed that in all discussions of gas engine introduction not one attack has been made on any part of the plant except the engine.

To summarize we should say that, given proper operation, any one of the three types of plant is reliable and could be recommended by an engineer for continuous service.

Regulation.—Regulation applies to prime movers in two ways, that is, to speed of revolution, and to cyclical variation of speed during a single revolution. The latter may be called "variation," the former simply "regulation." Steam engine contracts now call for a regulation of 1.5 per cent. and a maximum variation of 1½° in phase. That sufficient regulation may be provided in steam engine plants for the paralleling of alternators, the crucial test of all regulation, is shown daily by a large number of plants.

The steam turbine is capable of the closest kind of governing, and in a number of tests has shown its superiority. The turbine and gas engine are opposed in this respect. The former receives its energy in a continuous stream and can be governed at any instant, while the latter, receiving its energy in impulses, becomes a more difficult problem.

There are, generally speaking, 4 methods of governing gas engines, viz.—(1) "hit-or-miss," (2) throttling, (3) impoverished charge, and (4) variation of explosion point. The first of these, in which the charge of explosive mixture is entirely cut off at some periods of admission, is unsatisfactory for large engines; the fourth is uneconomical; the third is a modification of (1) and is even less desirable. It is probable that throttling will be the method adopted for all gas engines eventually. Throttling in a gas engine has none of the objectionable features that the same method has in steam engine work.

In this country gas engines in large sizes have been built after three types, viz.: The 3-cylinder single-acting 4-cycle type, receiving energy two-thirds of every revolution; the 2-cylinder single-acting 2-cycle tandem type, receiving energy at every stroke; and the 2-cylinder double-acting 4-cycle tandem type, receiving energy at every stroke. Double engines are frequently built of the two latter types. Experience has shown conclusively that an engine which receives energy as frequently as every two-thirds of a revolution can be governed sufficiently well for any purpose. Stations might be mentioned that are running alternators in parallel with the above types without trouble. The writer has in mind a large gas engine installation of several years ago where they had considerable trouble with regulation but a change in the governor design removed all trouble.

Since the work is being done every day satisfactorily by steam engines, steam turbines and gas engines, there would seem to be little room for argument on the score of regulation.

Cost.—It is very hard to give any figures of cost that are closely approximate for all cases that may come up. There are, in every proposition, peculiar circumstances which cause certain items to increase or decrease in cost and so change the total estimate. Every plant that is to be designed, therefore, must be discussed and settled as an independent proposition. On the other hand, there are certain average values, especially if we limit our scope, which will serve as guides as to what we may expect, and may be taken as starting points for more detailed examination.

TABLE I.—*Power Plant Costs. First Cost, Dollar per Kilowatt.*

	Steam Engine.	Steam Turbine.	Gas Engine.
Building and foundation	$12.00	$6 00	$10.00
Auxiliaries and piping	8 00	6.00	included in engine
Engine and generator	32.00	30 00	74.00
Total	52.00	42.00	84.00
Boiler room or producer shed (including pumps, heaters, piping, economizer and stack)	12.00	12.00	included above
Boiler and stoker (erected)	14.00	14.00	20.00
Total	26.00	26 00	20.00
Grand total of first cost per kilowatt	78.00	68.00	104.00
Operating Cost, Dollars per Kilowatt-Year.			
Fixed charges, 15 per cent. of cost	$11.70	$10.20	$15 60
Labor	6.20	5.75	4.40
Oil	1.50	.60	1.80
Coal	14.60	14.60	7.30
Total of operating cost per kilowatt per year	34.00	31.15	29.10

Notes.—Capacity of each plant, 4,500 kw. in three 1,500 kw. units.
Interest, depreciation and taxes, 15 per cent.
One year = 7,300 honrs (365 days of 20 hours).
Load, electric railway of 50 per cent, load factor.
Cost of coal, $2.25 per ton of 2,240 pounds.
Two-engine horse power = 1-boiler horse power.

In the accompanying Table I. the writer has arranged a table of comparative costs, representing present prices for labor and material and quotations from manufacturing companies. The figures apply to the following plants: (1) A steam engine plant, consisting of a compound Corliss engine running condensing, without superheat, and supplied with steam by horizontal water tube boilers with cast steel headers; (2) a steam turbine plant under the same conditions as the steam engine plant; (3) a gas engine plant with horizontal gas engines and Taylor producers. Other data are given in the table, and the following is a discussion of the various items.

Lot and Buildings.—A desirable spot for a power house always costs considerable money. It may on account of distribution requirements have to be in the settled portion of town where land is high, though an engineer will consider matters a long while before settling where he will haul every pound of coal in carts, and buy every pound of water. This illustrates a point in question. In Philadelphia, if using city water, a 6,000-kw. station on railway load would require about $3,000 worth of boiler water. To run condensing, if in the center of town, an expensive cooling tower plant is necessary, as enough city water would cost about $50,000. All this would be entirely avoided if the location were near a body of water. On the other hand, desirable river sites are not low priced. No values can be given.

When we come to consider relative amounts of space required for different types of plants, we have an interesting problem. In a paper by Mr. E. H. Sniffen (Am. St. Ry. Assn., 1902), several interesting curves are given (reproduced in Fig. 1 herewith), showing the floor space required for horizontal steam engines (Curve I.), vertical steam engines (Curve II.), and the Parson's steam turbine (Curve III.). The writer has added on the same diagram the curves for the Curtis steam

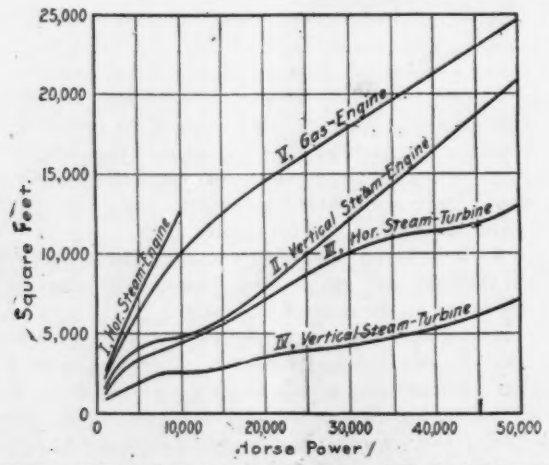


Fig. 1.—Diagram of Floor Space Required for Different Kinds of Prime Movers. for Various Capacities of Plant.

turbine (Curve IV.) and the average gas engine (Curve V.). Mr. Sniffen assumed for his conditions 7 feet of clear space all around for the following plants: Two 400-kw. units; three 750-kw. units; four 1,000-kw. units; three 2,500-kw. units; four 2,500-kw. units; four 5,000 kw. units; seven 5,000-kw. units; and ten 5,000-kw. units. This classification will answer our present purposes. The diagram shows the Curtis turbine to some advantage, for if volumetric engine room capacity were considered the two types of turbine would require about the same space, owing to the greater height of the Curtis type. The Curtis type has an advantage in this respect, however, since its height is not excessive and adds nothing to the cost of the building.

But this diagram does not tell the whole story. The boiler capacity is the same for engines and turbines and if an engineer designs his engine room before his boiler room, and on an economical basis, he may be somewhat surprised. In the sketch diagrams, Figs. 2 to 4, is shown a plant of three 1,500-kw. vertical turbines, with the required boiler capacity, laid out in three different ways. Fig. 2 shows the ordinary back to back arrangement which evidently lacks economy. In Fig. 3, the boilers are thrown into two sections on the same level, while Fig. 4 shows a double-decked arrangement. Fig. 5 shows that conditions are

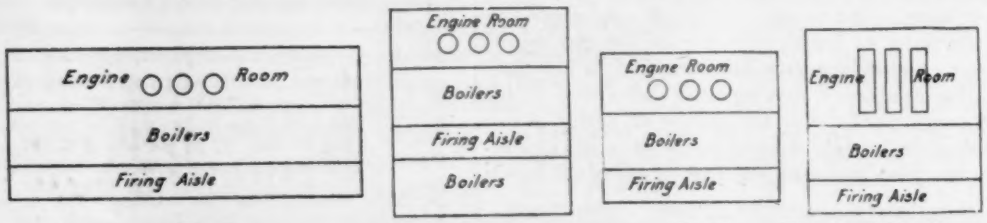


Fig. 2. **Fig. 3.** **Fig. 4.** **Fig. 5.**—Station Arrangement Similar to Fig. 4, but for Horizontal Steam Turbines.

Figs. 2, 3 and 4. Sketches Showing Three Ways of Arranging a Power Station using Vertical Steam Turbine.

not materially different for the horizontal turbine. The extra space not needed by the engines in these lay outs, especially Fig. 2, could be used for other purposes, if such a long narrow lot were under discussion. When we remember the cost of installation and repairs, and the added risk of such an excessive length of high pressure piping, and also that about .07 pound of steam is condensed per square foot of covered steam pipe, we shall not have much liking for that lay out. In most cases there would be an added expense on the coal handling account.

Engineers have seldom designed double-decked boiler houses except when forced to it by circumstances. In engine installations these cases have been very few owing to the large amouut of space required by the engines. Just why the double-decked arrangement should be objectionable is hard to state. The damage risk owing to the explosion of a lower boiler is almost nothing with the water-tube type, while the piping is exceedingly direct and economical. The chief difficulty would seem to be in the coal and ash handling, which is certainly not a great one. Figs. 4 and 5 show how compactly a plant might be designed on these lines, and the writer believes that in many cases this type will of necessity be adopted in steam turbine stations.

This calls to mind some of the arguments that have been heard lately in regard to replacing engines by turbines in old engine rooms and so getting more power in the same floor space. This is impossible unless we can expand our boiler room somehow. This may also demand the double-decked arrangement, owing to the impossibility of expansion in other directions. The double-fired boiler which is being experimented with by some just at present may alter these conditions somewhat, but probably not much.

In any case the turbine shows a great saving in engine room space, and room used for other purposes as suggested in Fig. 2, certainly cannot be charged to power. No value can be put down for cost of engine room that will suit all cases.

The gas engine will require a little less space than the steam engine, but a more expensive foundation, so the costs are assumed almost the same in Table I. A comparison of the space required for boilers and for producers shows some interesting facts. The amount of space assumed for boilers is an average of that required by several makes of the water tube type, though the most efficient make of this type known to the writer requires only 1.28 square feet total floor space, and occupies only 26 cubic feet per boiler horse power, which is very compact indeed.

In Table II. is given a summary of floor space required by producer plants of various capacities. This table was arranged for the writer by R, D. Wood & Co., of Philadelphia, Pa., and gives approximate values only for Taylor and Mond producers This shows an average value of 1.7 square feet per engine horse power, which is about the same as required by the boilers.

TABLE II.—*Approximate Dimensions of Space Required for Producer and Holder, for Taylor and Mond Gas Producer Plants.*

Capacity.	Length		Width.	Height	
	Taylor.	Mond.	Taylor Mond.	Taylor.	Mond.
500 horse power.	42 feet.	68 feet.	26 feet.	20 feet.	30 feet.
750 "	45 "	70 "	28 "	25 "	35 "
1,000 "	45 "	70 "	40 "	25 "	35 "
2,500 "	50 "	80 "	80 "	25 "	35 "
5,000 "	50 "	90 "	155 "	25 "	40 "

Auxiliaries and Piping.—There is no difference here between the steam engine and the steam turbine, remembering that the piping between the throttle and exhaust connection is included in the cost of the engine. The quotations for gas engines which the writer has been able to obtain do not permit of easy separation of costs, so a total is given. The external piping amounts to very little, and the auxiliaries to nothing outside of a tank for starting and a pump.

Engine and Generator.—Little can be said here, since the values given are direct quotations. The steam turbine should gain a little in the generator cost owing to its increased speed and the general reduction of weight, but one well-known firm quotes its turbine units at the same price approximately as its reciprocating units. For years generator design has been governed by the demands of the Corliss engine. The writer was concerned in the installation of two Corliss engines during the past year where the speed was 110 r.p.m., which is very close to the limit. Engines are running as high as 150 r.p.m., but most engineers would hesitate about going beyond 120 r.p.m. On the other hand, turbo-generators run at speeds varying from 1,000 to 4,000 r.p.m., according to size and frequency.

The cost of gas engines is certainly excessive. The writer has had quotations for large engines varying from $55 to $40 per horse power, f.o.b. works. These prices will come down, or the introduction of gas engines will be greatly retarded. This is the most serious handicap the gas engine has at present, in fact the only real one. The loss here cuts down a large part of its gain in economy. The best steam engines of this size can be bought for about 7½ cents per pound, gross weight, and it seems unreasonable that a gas engine should cost much more. The gas engine gains, of course, in the absence of auxiliaries.

Boilers and Producers—In the boiler room estimates we have included all that modern practice demands except coal storage and power handling of coal. How much coal storage is necessary, and how the coal will be stored, depend largely on local conditions. Engineers are storing coal in open yards, under covered sheds, under water in a few places, and in steel bunkers either suspended like the Berquist type or

of the old structural type. Power handling of coal will be found economical except in a small number of cases where the coal can be dumped close to and higher than the fire doors. Since the capacity of the storage and conveying plant for the gas plant need be only half that for the steam plant, there will be a saving here in favor of the former.

The figure quoted for the producer includes a conveyor to the top of the producers, a shed over the producers, and all auxiliaries necessary for delivery of gas to the engines. The figures apply to the simple Taylor producer; whether the Mond or other by-product producer will ever become popular among power engineers is a question that only time can answer. It depends upon how much the extra complexity is objectionable, and upon the demand for the by-product.

Operation and Fixed Charges.—We have lumped fixed charges at 15 per cent.; this means interest at 5 per cent., taxes at 2 per cent. and depreciation at 8 per cent. Depreciation on different parts of the plant will vary from 5 to 15 per cent., but 8 per cent. will be found to come very close to more detailed calculation. Depreciation on well-built gas engines will not be very different from that on the same quality steam engines. Depreciation on the foundations should be taken in every case at the same rate as on the engines, since they are useless when the engines are taken out and must be removed.

The gas plant gains in the labor item on account of the smaller amount of coal to be handled, both as coal and as ashes, smaller cleaning and repair force, and the absence of auxiliaries in the engine room. As stated elsewhere our conditions are coal at 0.1 cent per pound, a year of 365 days of 20 hours each, and a 50 per cent. load factor. This means that the total yearly wattmeter reading is one-half the rated yearly kilowatt hours of the station. Under this definition the usual electric railway load factor is about 50 per cent. The load factor will influence calculations on oil and coal costs.

We have assumed the coal consumption to be the same for steam engines and steam turbines, *i. e*, 4 pounds per kw. hour, and 2 pounds per k.w. hour for the gas engine. This is as close as one is warranted in estimating in a case of this kind. The best water rate the writer has seen recorded for a 2-cylinder condensing engine with superheat is 10.17 pounds per indicated horse power, which is about 17 pounds per kw. hour. This is very low, for 19 pounds per kw. hour is considered unusual and 25 pounds is probable average. So far the steam turbine has not done better, though whatever economy it has at the start it is likely to keep until it breaks down, since experience shows that there is nothing to wear except the bearing. It should be noted that the high values given above depend upon high vacuum, superheat and very close attention. Theoretically, and in contract trials, 27 inches of mercury is a very ordinary vacuum, but in a large number of stations that the writer has visited in the last few months the vacuum was seldom over 23 inches. We must have considerable education along this line if we are to realize the greatest economy, particularly with the turbine, since its efficiency seems to suffer more from poor vacuum than does that of a steam engine.

General Considerations.—If what we have said be true the "three-cornered fight," of which the technical journals have been talking, ought to be already over, but this is far from being so. In the above estimates, using what are meant to be conservative figures, there is a yearly saving, per installed kilowatt, of $2.85 by the steam turbine and $4.90 by the gas engine over the steam engine. These seem like very great differences, but they may become even greater with increased experience.

The writer believes that from now on the decision will usually lie between the steam turbine and the gas engine for all units. The simplicity of the steam turbine is really the source of its many advantages. One has only to stop and think of the hundred adjustments, places to wear, etc., of the reciprocating engine to realize this. We have become so accustomed to them that they seem very simple, but they are not. Watch the engineers and oilers on a Manhattan type, or even a less ponderous engine, and then see the one man on a steam turbine with nothing to examine but a bearing or two, and these accessible without a climb of 30 feet in the air or a walk of 200 feet on the floor.

We formerly heard much about the greater economy in the use of steam by means of the steam turbine, but later experiments have shown these statements to be unwarranted. Owing to the absence of valves and of lubrication on the steam surfaces, the use of superheat is very easy. In Europe the difficulties of superheat in connection with reciprocating engines seem to have been entirely eliminated. With us, superheat has been almost a bugbear, and just the reason for this is hard to state. True, it will always be more troublesome than saturated steam, even with the steam turbine, for we shall still have our long lines of piping; nevertheless the steam turbine renders its use much easier.

We have already referred to the necessity for very high vacuum in steam turbine work, and this fact should be kept in mind. Regulation can be made almost perfect owing to the absence of reciprocating motion and the continuous supply of energy. Since there is no oil in the exhaust the water may be used over and over, a very important point where water is costly. When conditions demand it, the time for manufacture and erection can be made exceedingly small. In short there is every reason why an engineer can afford to install a steam turbine rather than a steam engine, even if it did not mean such a large direct saving in cost of power.

But our figures also show the gas plant to be best of all. The question might therefore be put as to why the others are not immediately and completely discarded. There are many reasons, of course, but the chief ones are very apparent.

First, the field is new and men must be absolutely sure, not reasonably so, that the wheels will turn; second, many of the manufacturers of gas engines are also interested in steam engines and steam turbines, and consequently the energy applied to the introduction is divided; and third, the first cost of the gas engine is excessive. Whether the gas engine is more economical than the steam turbine depends on the relative prices of the engines and the price of coal.

In the calculations summarized in Table I., a single value was taken for the cost of the engine and a sigle value for the coal. To show how changes in these amounts would affect our results, the curves in Fig. 6

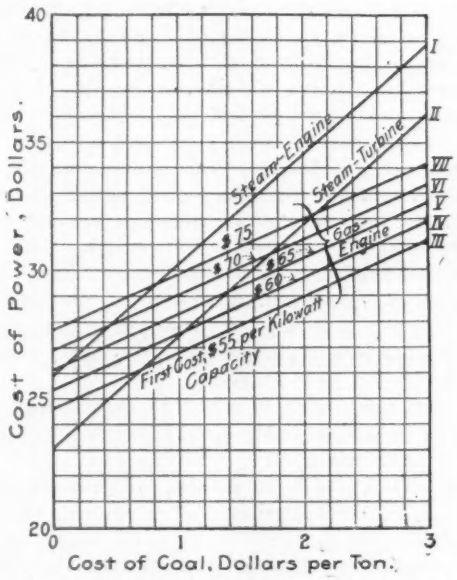


Fig. 6.—Curves of Power Cost for Steam Engines, Steam Turbines, and Gas Engines, for Various Prices of Coal.

are presented. Here abscissas represent cost of coal in dollars per ton and ordinates represent cost of power in dollars per kilowatt-year under the previous conditions. Curve I. is for the steam engine, Curve II. is for the steam turbine, and Curves III., IV., V., VI. and VII. for the gas engine when the engine alone costs $55, $60, $65, $70, $75, respectively, per kilowatt of capacity. The points at which the gas engine curves cross the steam turbine curve show the minimum prices of coal for which the gas engine is as economical as the turbine. At present prices of engines coal must cost at least $2.15 per ton to justify installing gas engines on the score of economy.

This excessive price of gas engines also acts in an indirect way to retard its introduction, on account of the well known objection of financial men to high first cost. It is hard enough just now to convince the skeptical, without having this added handicap.

In Europe no engineer would hesitate to install gas engines unless he could obtain power more cheaply by some other means. It is regarded there as entirely reliable, but is placed only in the hands of men who have a thorough training in its requirements and possibilities. It is theoretically and practically much more efficient than any steam prime mover, the plant is remarkable for its simplicity and consequently the liability to shut down is greatly reduced. The plant has great possibilities of power storage at little cost. The producer is probably 10 per cent. more efficient than the steam boiler, and even more so if the condensation losses in pipes, traps, etc., be included. Indeed a poorer quality of coal might be used in the producer for results equal to those of the boiler.

It seems almost a law that an inferior type must be developed to its highest efficiency, while a superior one waits its turn. We shall therefore wait a little while for the general introduction of the gas engine;

but only a little while, since fortunately the steam turbine is going ahead with rapid strides and would seem to have little farther to go. There are companies to-day handling all three types that could afford to drop their steam apparatus and come out boldly as champions of the gas plant. Soon perhaps we shall realize the ideal of a single large power station for each community—a large station in the outskirts of the city, near a body of water, with no smokestacks, consisting of a gas engine plant running on producer gas with a by-product factory in the rear, leaving nothing to be hauled from the plant but a useful finished product. Meanwhile the world will have about three times as long to search for the substitute for coal.

Maximum Distance to which Power Can be Economically Transmitted.

The *Electrical World* notes that at the meeting of the American Institute of Electrical Engineers held the last week in December, 1904, Mr. Ralph D. Mershon read his International Electrical Congress paper, which develops an equation for determining the maximum distance to which power can be economically transmitted. We give below a condensation of that portion of the paper which precedes the mathematical part.

The author, in the introduction, states that the method of treatment will, with suitable changes in the values of constants, apply so long as present methods of power transmission obtain, and makes possible a comprehensive view of the possibilities of long distance transmission.

The elements which, in the broadest sense, limit the distance to which power can be economically transmitted, are the cost of power at the generating station, and the price which can be obtained for the delivered power. The difference between these two elements must cover the cost of transmission, the interest on the investment and the profit. The cost of transmission comprises the loss of power in transmission, the cost of operating and the cost of maintenance and repair. The value of the sum total of the interest which must be paid upon the investment, and the minimum profit which is considered satisfactory, will have much weight in determining the limiting distance of transmission. The less this sum is the farther power can be transmitted; a low interest rate and a low rate of dividend will, therefore, be conducive to long transmissions.

In a general way, the manner in which the investment in a transmission plant and the annual charges and expenses in connection with the plant vary with different outputs, voltages and distances of transmission, is as follows: For a given voltage, drop and distance of transmission, the cost of all the apparatus and equipment, except the line conductors, will increase more slowly than the output of the plant. That is, the greater the output of the plant the less the cost per kilowatt of all the equipment, except the line conductors. This will be true of the operating expenses also. Therefore, since the interest charges and the charges for depreciation and repair are dependent upon the investment, the greater the output of the plant the less will be the quantities going to make up the annual cost per kilowatt of transmitting power, except those depending upon the line conductors. Since the weight of the line conductors under the conditions assumed will vary directly as the amount of power transmitted, those elements of the annual cost per kilowatt depending upon the line conductors will be practically constant for all amounts of power transmitted and cannot be materially reduced by increasing the amount of power transmitted. With the same voltage, economic drop and output, the elements of annual cost per kilowatt due to the line structure (pole line) and to its extent (patrolling, etc.), will increase directly at the distance. But any increase of cost in line structure due to increase in distance can be offset by increase of output. On the other hand, the weight of the line conductors increases as the distance (for the same *economic* drop) and the elements of annual cost per kilawatt due to the weight of the line conductors will, therefore, increase as the distance, no matter what the output.

It appears, therefore, that all the elements in the annual cost per kilowatt for transmitting power, except those dependent upon the line conductors, may be continually reduced by increasing the amount of power to be transmitted. The annual cost per kilowatt due to the line conductors cannot be so reduced. It can be diminished only by such other means as will reduce the first cost of the conductors. As the first cost of the line conductors can be reduced only by increasing the voltage of transmission and as there is a limit to which such increase can be carried, it follows that *the limiting distance to which power can be economically transmitted will depend, finally, upon the cost of the line conductors and upon this alone.*

The limit of voltage referred to is not necessarily that due to physical considerations, such as difficulties of construction, air losses between conductors, etc.; for, leaving such matters out of consideration, it is easy to imagine the voltage carried to such a high value as will reduce the line conductors to the point when the increased cost of transformers and insulators, due to a further increase of voltage, will overbalance the saving in the line conductors, due to such further increase.

To simplify the treatment of the subject, it is assumed that in the cost of transmission is included the interest on the investment (bond interest) and that over and above this cost there must be earned a certain percentage, which percentage will represent profits (stock dividends). In addition the following assumptions are made:

Power purchased at low tension bus bars of step up transformers and sold at outgoing bus bars of the step down station.

Frequency of transmission not less than 25 cycles nor more than 30 as being the limiting frequencies which, while favorable to the transmission of power, are yet suitable for almost all purposes to which power can be applitd.

Idle synchronous motors at step down station to correct for power factor, the average power factor of the line being held as near unity as possible. In the plants of large output dealth with the possible approximation to unity power factor will, in spite of the line charging current, be sufficiently close, for practical purposes, to justify the assumption of unity power factor.

No matter what the capacity of the plant, there will be three transmission lines, each capable of carrying one-third the load; the power factor of the load supplied will be 0.8; the number of transforming units at each end of the line be 18, each transformer being normally worked at $\frac{2}{3}$ of its rated capacity, so that one bank of 3 may be cut out, if need be; the number of connective synchronous motors will be 6, each being worked at $\frac{2}{3}$ of its rated capacity. The kilowatt ampere capacity of these synchronous motors must, for a load power factor of 0.8, be equal to $\frac{1}{4}$ of the kilowatt capacity of the load carried by the plant.

It is evident that the number of units must be considered as the same for plants of all capacities in order to take full advantage of the decrease of cost per kilowatt, due to increase of capacity.

The pole lines are assumed as constructed with 12 steel towers to the mile.

Ideal conditions are assumed throughout consistent with delivering reliable and cheap power. Since the object is to determine the *maximum* distance, the factors fixing commercial costs of apparatus are taken at the lowest values likely to obtain.

Later on in the paper general equations are derived expressing the relations between the distance of transmission and the quantities which govern it. By making assumptions in addition to those mentioned above, as to the values of the various coefficients in the general equations, and as to the purchase and selling price of the power, several curves were laid down. In obtaining these curves the constants were values favorable to long transmission distances. The costs were taken lower than those ordinarily current in the endeavor to anticipate somewhat possible future prices. Also, the cost of power purchased at the step up station was fixed at the low figure of $10.90 per kilowatt per annum.

The diameters of conductors in the curves and the voltages to which they correspond were compared with the values of diameter and critical voltage given by Prof. Harris J. Ryan in his recent Institute paper on that subject, and the diameters from the curves were found to be considerably above those of the paper. The values are affected by the price paid for power at the step-up transformers, but if this be taken even as high as $20 per kilowatt per annum instead of $10.90, the diameters of the conductors remain below those for the critical voltages. It appears, therefore, in the light of present knowledge that the limit of voltage will come through economic conditions and not through conditions depending upon atmospheric losses.

Power prices are so dependent upon conditions, especially those arising from the location and magnitude of the market and of the supply, that any figure chosen will be objected to by some as too high and by others as too low. The same condition applies to the price assumed as that paid for power at the step-up station, but in a lesser degree. The figure assumed as the price of the power sold, $34 per kilowatt per annum, is one which seems to be fairly representative, especially in the case of the large blocks of power. The values taken have been chosen as being as nearly representative as possible of the heat conditions which might obtain, favorable to long-distance transmission.

The voltages involved are much higher than those now in use commercially, but they are not beyond the range of future possibility. Manufacturers will now undertake commercial transformers for voltages as high as 150,000 volts, and there is little question that when the de-

mand shall come for units of the large capacities contemplated herein, the voltage requirements will be met. Such transformers will be structures of sufficient size to permit of being gotten at and worked upon from the inside as well as the outside, and this, in connection with the fact that more space may be utilized for insulation, will render construction for high voltages much less difficult than at present.

The maximum amount of power dealt with, 500,000 kw., is probably too high to be seriously considered at this time, but from 200,000 to 300,000 kw. is believed to be within the range of immediate future possibility. In a plant of this size it is probable that a net return of 12 per cent. would be required, not alone for the purpose of dividends, but also as a protection to the bonds.

Under these conditions the curves show the distance of transmission to vary from 512 miles for 212,000 kw. to 623 miles for 300,000 kw. For the present outlook, therefore, the limiting distance of transmission will for some time at least be in the neighborhood of 550 miles. It also appears that voltage limits will be fixed not by conditions depending upon atmospheric losses, but by economic conditions. The latter conclusion is perhaps, of greater importance than the subject forming the title of the paper.

The discussion of the paper was participated in by President Lieb and Messrs. H. G. Stott, Philip Torchio, J. F. Wallace, C. H. Parmly, M. H. Gerry, Jr., A. E. Kennelly, Charles F. Scott, C. L. de Muralt and P. G. Gossler. Mr. Stott pointed out that the transmission of power from Niagara Falls to New York comes well within the limits defined by Mr. Mershon. He did not approve of any formula dealing with the question that does not take into consideration the load factor, and he did not believe that power from any steam plant would cost as much as $34 per kilowatt, and that very few water power plants could sell power at $10.90. He thought that there is a wide scope for discussion as to whether a frequency of 25 cycles is not too low, particularly since in the West 60 cycles are used almost exclusively, which higher frequency assists to compensate for a large lag.

Mr Torchio referred to the mistaken interpretation often given to the Kelvin law for the determination of the cross sections of conductors. Requirements as to the safe carrying capacity of wires, the regulation, brush discharges of high tension lines, etc., may substantially modify the conclusions arrived at through the use of the law. He criticized the assumption of $10.90 per kw. per annum for line losses, to which is contrasted the assumption in the paper that the greater the output of a plant the less is the cost per kilowatt of all the equipment; the capacity of plant to provide for less can certainly be increased for considerably less than the average cost of the entire plant. He did not agree that the cost of power will materially increase, for it will be fixed for centuries to come by the cost of power derived from coal. At present the total coal consumption in this country is exactly 1,000,000 tons per day, while that used in electrical generation is less than 2,000,000 tons per annum.

While the cost of coal will probably increase, it is also quite probable that the efficiency of the heat engine will also be increased. He estimates that the total cost of generating equipment for a capacity of 2,075,000 kw., which is that now installed in this country, would amount to $207,500,000, involving an annual charge of $25,937,500, which added to the cost of the fuel would make the total $47,137,500, to be compared with the $70,550,000 cost of water power. The assumption of $34 per kw. per annum is consequently excessive, and on the basis of the operation of all electric light and railway stations of the United States for the year ending June 30, 1902, the price should have been reduced to $22.72. He believed that if water power is ever transmitted to large markets like New York it will be necessary to keep at these centers a reserve steam generating capacity, first for tiding over shutdowns of the transmission power and second for taking care of the peak load.

Mr. Wallace pointed out that one of the important conclusions of Mr. Mershon was based upon a curve, the significant part of which is quite flat, and that if this curve were corrected for the increased cost of insulators at high voltage and increased cost of transformers, a much lower economic voltage would result than that accepted by the author. Moreover, at lower voltages there is increased reliability of operation, which again modifies the conclusion to be drawn from the curve. He believed that any decision regarding transmission potentials should take into consideration greater reliability of operation at lower voltages, and that good engineering would soon create a condition whereby the line cost would increase directly with the output, owing to the use of multiple lines. Mr. Wallace also criticized the manner in which the author of the paper made the factor of total investment enter into the equations, which affected the correctness of the formula given for profitable efficiency. Load factor, he said, on both line and generating stations also affects profitable efficiency, though neglected by the author. He considered that the figure of $62.50, which is deduced as the cost of the generating plant per kilowatt, is entirely too low and that the cost of the hydraulic development alone would exceed $90 per kilowatt. He also said that an error was made in the application of Kelvin's law to the case.

Mr. Parmly criticised one of the equations, which he said was improperly solved for the reason that it was treated as an equation of one variable, whereas it contained three variables. Mr. Gerry said that he had always considered mathematical analysis of a question of the kind treated in the paper as a doubtful utility, not because the analysis itself may not be correct, but because of the fact that there are so many things entering into it that require assumptions involving engineering judgment on matters yet in the future, that the results may be nothing more than curiosities so far as practical purposes are concerned. By modifying the assumptions of the paper, it would be easy to show that the economic distance of transmission is limited either to 200 miles or 2,000 miles, and consequently analyses of the kind are merely an example of mathematical gymnastics. He considered that there is nothing before us that would justify the assumption of limitation of 500 miles or 2,000 miles, and he believed it a mistake to bring before the Institute results from the mathematical development as given in the various curves, since they may mislead persons not familiar with the subject and may even mislead engineers.

Dr. Kennelly said that he thought it only fair to the author to recognize that the paper is merely a statement of possibilities under assumptions cleaaly outlined and that it did not pretend to serve as a standard for commercial practice of the present day; the voltages dealt with go as high as 170,000 volts, while the highest voltage now used is something like 60,000 volts. The paper is interesting in so far as it goes in showing that under the conditions assumed, which are certainly not the conditions of to-day, and perhaps are conditions never to be realized, it would be possible to buy power at $10.90 and sell it at $34 at a distance of 500 miles. Mr. C. P. Scott, in referring to the work of Mr. Mershon in experimenting some years ago in the West on the limits of high voltages in transmission, said that he himself, in making the experiments the subject of an Institute paper, had presented the conclusion that 60,000 volts was the upper limit. He said that he has been sorry for the statement ever since, for later developments had shown that the diameter of transmission wire was a factor, a larger diameter than that used in the experiments increasing the value of the critical voltage. The sizes of wire, with the great quantities of energy with which the paper dealt, becomes so great that the limiting voltage no longer determines the maximum voltage of transmission. Mr. de Muralt thought the selling price used by Mr. Mershon was entirely too high. In Switzerland, the ordinary price at which power is sold is about $22 per horse power per year or $30 per kw per year, notwithstanding that coal there is worth from $6 to $8 per ton; with cheap coal as in this country, he believes that there would be great difficulty, no matter how large the amount of power and no matter how long the transmission distance, to sell any considerable amount of power at $34 per year. Mr. Gossler having critized the statement of Mr. Torchio as to the cost of power, the latter said that the low figure which he gave is the cost of production with interests and depreciation of machinery, and is exclusive of real estate and buildings; that the selling expenses of a company which retails the power must be included, and a number of other items such as depreciation, interest and taxes on real estate and distributing lines, cost of distribution and general expenses.

Mr. Mershon, in closing the discussion, said that in his paper he had done in a general way just what an engineer does when he estimates on a specific plant. By means of formulas and comparatively few values he obtained a curve which will give some idea as to the extension of distance, of the various outputs and other quantities which economy would indicate should be followed. He did not consider that in the problem the load factor need be considered or any charge except the flat rate. All that was necessary was to divide the income by the peak, which gives a certain first rate. In the steam plant fuel is a variable factor, but in the water power plant it costs practically the same per kilowatt, whether the whole or only a fraction of the output is delivered. He considered that while the cost of the generating plant was low, it was not as low as it might in some cases be. In view of the fact that the load is generally bunched up at the end of the line, a low frequency is undoubtedly advisable, a higher frequency only being beneficial when the load is distributing along the line. As to prices of power in Switzerland, while on this side material is cheap and labor dear, on the other side labor is cheap and material dear. Concerning the criticisms of Mr. Wallace and Mr. Parmly, he said that it seemed to apply to the Kelvin law.

Revival of American Machine Exports to Germany.

Iron Age reports that Consul-General Frank H. Mason, Berlin, Germany, furnished the following interesting report to the Department of Commerce and Labor:

For several obvious reasons, which have been cited from time to time in these reports, the exports of American machinery and machine tools, which reached their highest development in 1899–1900, declined in 1902 to about one-third of their greatest volume. The causes of this falling off were mainly three: The general prostration of manufacturing industries in Germany at that time; the fact that German machine shops equipped with American machinery had learned to duplicate most of such machines and many other articles at less than the cost of the imported originals, and that many American manufacturers had established branch factories in Germany, the products of which competed directly with the output of the parent manufactories in the United States.

It is now apparent that the period of lowest depression is definitely past, and that, notwithstanding all adverse influences, the export of American machinery to Germany is increasing in due proportion to the general recovery of industrial activity in this country. The measure of this renaissance of a once flourishing and important trade will be apparent from the following comparison of the total imports of certain classes of American machinery during the first 9 months of the years 1903 and 1904:

Kind of Machinery.	1903. Metric Tons.	1901. Metric Tons.
Sewing machines	1,570	2,339
Machine tools	724	1,634
Metal cutting and boring machines.	91	206
Pumps	109	142
Typewriters	90	114
Electrical machines	27	63

Two reasons are ascribed for this rather unexpected increase in the machine imports which compete most directly with home-made products—namely, the conviction which prevails in many quarters that the original machine, made in the country where it was invented, is superior to any copy or reproduction of alien origin, and, secondly, the fact that since the demands of the American home market have relaxed, with the diminished activity of the past 15 months, our manufacturers and exporters have given more attention and effort to their foreign trade.

It is just this point in the present revival that is worthy of being recorded and its significance recognized. In an old and highly developed country like Germany, where not only the wants of its people in manufactured merchandise are fully covered by home made-products, but a large surplus of most goods is produced for export, the importation of similar wares from foreign countries must depend largely upon the intelligence and energy with which trade is pushed by the exporter and his agents in German markets. It is a settled belief in Europe that Americans, although unsurpassed as manufacturers and caterers to their own countrymen, have only an incidental interest in foreign trade, and that this interest, such as it is, fluctuates in close and direct relation to the condition and demands of the home market. During the highly prosperous period of 1902–1903 in the United States the export of many articles to Europe languished because manufacturers at home were too busy to attend to orders and correspondence from abroad. Complaints were frequently brought to consulates that American exporting firms would not even answer inquires as to prices and conditions of delivery. It was at this time that the financial correspondent of the London *Times*, being sent to make an exhaustive study of the growing "danger" in the United States, encouraged his readers with the assurance that:

The truth is that foreign trade in any systematic way is now beyond the knowledge of the American people. I was almost tempted to say that it is beyond their desires and intentions. That in an indefinite way they would like to have a foreign trade is perhaps true; but for the reason that they have been so long accustomed to look to the home market it is impossible for them to take the steps that would give them any considerable share in foreign markets. After all, Americans are the most conservative people in the world so far as outside conditions are concerned, and so where these are involved they are content to go on doing a foreign trade that is merely complementary to the home trade.

If Count Goluchowski and some of the German, Russian and French dreamers could only know the real truth about this people they would have little reason to concern themselves with their new bogey, the "American danger."

This is, of course, an extreme and therefore misleading statement of the case. The fact is that a great many, perhaps a majority, of American manufacturers and merchants are indifferent to export trade, and as a consequence careless and ignorant concerning the methods by which it should be developed and maintained. They regard foreign markets only as a convenient outlet for their surplus products in time of over-production resulting from dullness and depression in the home demand. Notwithstanding all that has been said and written, they go on sending catalogues and circulars in English with values in dollars, weights in avoirdupois, measurements in feet and inches. They insist rigidly on American terms "Cash against B. of L.," and kindly inclose a United States stamped envelope for the reply of the expected customer.

But, on the other hand, there are a large number of American manufacturers and exporters who really know that they want export trade and have taken up the work of establishing, developing and maintaining it with all the energy, skill and adroit adaptation of means to ends which distinguishes them as manufacturers and caterers to their home trade. They have come to Germany and established agencies, either with German firms of high standing or as branch offices under their own management; their skilled salesmen have traveled over the Empire with samples and price lists printed in German units and currency, and their goods are known here for just what they are, no more nor less. It may fairly be assumed that when the manufacturers and merchants of the United States definitely make up their minds that they want a broadly developed, progressive and permanent foreign trade, they will go about the work of obtaining it as ably and successfully as they have mastered the resources and capabilities of their own country.

It is because American pumps, machinery, typewriters, shoes and many other manufactured articles are well known and appreciated here that the demand for them has recovered and kept pace with the general revival of prosperity in this country. The greatly increased importations of the past 9 months are evidence of a vitality in the German market that will repay any intelligent, well considered and directed effort. No European people buy more readily and liberally what they want, none are more free from narrow prejudice against merchandise of foreign origin, none are more keenly interested in every novelty and valuable improvement than the Germans. If the field here is less ready easily worked than it was 10 years ago, it is only because German manufacturers now supply cheaply and in unsurpassed quality many of the goods which were then imported, but there are still lucrative markets in the Fatherland for those who will seek them discerningly and cultivate them with intelligent and persistent energy.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. ARTHUR E. BOARDMAN'S New York offices are now in No. 41 Wall street, room 1707.

MR. RUSSELL ROBB has been admitted to partnership in the firm of Stone & Webster, Boston, Mass.

THE Suffern (N. Y.) Gas Company proposes to have a try for the public lighting of that place. It is intended to use the Welsbach system.

THE Boston (Mass.) *Record* says that after a battle royal of lawyers, gas experts and self-appointed spokesmen for the public, the report of Engineer C. J. R. Humphreys will be accepted by the Board of Gas and Electric Light Commissioners. Mr. Humphreys is the expert who valued the machinery and other properties of the Boston Gas Companies, which valuation was made for the purpose of fixing the capitalization of the proposed Boston Consolidated Gas Company. For two weeks, says the *Record*, F. B. Snow, as Attorney, and Corporation Counsel Babson for the city of Boston, and Commissioners Barker, Schaff and George asked Mr. Humphreys various questions about his methods of fixing values, and the net result is that the expert's figures will be found satisfactory, although the acceptance of the report by the Commissioners does not bind them to treat all of his figures as final in the settlement of the case. Speaking on our own account, we say that this acceptance is a distinct triumph for Mr. Humphreys, whom every gas man of straightforward type will at once acknowledge is a master of his profession.

A CORRESPONDENT in Nashville, Tenn., writing under date of the 26th December, says: "Christmas Eve, Mr. John E. Hood, Manager of the Knoxville (Tenn.) Gas Company, was presented by the employees of the Company with a handsome gold watch chain and charm. The presentation occurred at noon, when Mr. Hood was summoned before a mock court held in the workshop and presided over by Mr. W. R. Hicks. The defendant was tried and adjudged guilty of many acts of kindness to numerous employees, and the penalty was that he should accept the memento with many Christmas greetings from the men. The presentation was made by Mr. Fritz Jabolewski, the office manager. The convicted responded with eloquent speech, expressing his appreciation of the gift, and of the spirit that prompted it."

MR. ALBERT R. WILLARD has resigned the position of Superintendent of the Greenfield (Mass.) Gas Light Company. He was with the Company several years.

MR. H. M. LITTLE, of Chattanooga, Tenn., has been appointed Vice-President and General Manager of the San Antonio (Tex.) Traction Company, succeeding Mr. Reagan Houston.

A CORRESPONDENT in Cedar Falls, Iowa., writing under recent date, says: "The Waterloo and Cedar Falls Gas and Electric Light Company has filed articles of incorporation. The Company is capitalized in $595,000, and it has a bonded indebtedness of $150,000. It was organized to take over the properties of the Waterloo and Cedar Falls Gas and Electric Company and of the Cedar Falls Electric Light, Heat and Power Company, and to build a gas plant Cedar Falls. It will own and operate the electric light and power plants in Waterloo and Cedar Falls and the gas plants in both cities. The officers are: Directors, John H. Leavitt, Geo. W. Dawson, George McLean, C. P. Bratnober, C. E. Pickett, C. F. Fowler, George E. Lichty, C. A. Wise and C. A. Rownds; President, George McLean; Vice-President, George E Lichty; Secretary, H. B. White; Treasurer, W. W. Miller."

THE old plant of the Bridgeport (Conn.) Gas Light Company on the the Housatonic river has been shut down and the output is being sent from the remodeled works at the West End.

AT the annual meeting of the Peoples Power Company, of Moline, Ills., a reduction in the rate for electric current used on illuminating account was ordered, and it was also decided to set aside the sum of $50,000 for use on construction account. The officers chosen were: H. A. Ainsworth, President—succeeding the late C. O. Nason; Philip Mitchell, Vice-President; C. H. Deere, Treasurer; S. S. Davis, Secretary.

MR. JOHN B. ELMENDORF, who is in charge of the affairs of the Fishkill and Matteawan, N. Y., Gas Company, has authorized the Gas Machinery Company, through its Eastern representative, Mr. J. A. Mayers, to install a complete scrubbing, condensing and purifying apparatus on the plant. An exhauster goes with the outfit.

THE Portland (Ore.) Gas Company has arranged for the extension of its service next spring to Mount Tabor.

A CORRESPONDENT in Toronto, Ont., writing under date of December 27th, incloses the following: "A representative of one of the oldest and best known families in Toronto, passed away early Christmas morning, in the person of Henry Cawthra, Yeadon Hall, Beverly and College streets. Deceased was the son of John Cawthra, one of the United Empire Loyalists who came to North America in 1812. He was born in Newmarket, Sept. 2, 1830, received his education at Upper Canada College, Kings College and at Osgoode Hall. Deceased, although not given to publicity on personal account, was well involved in that which concerned the best social, financial and commercial interests of the city in which he lived so long and served so well. At the time of his death he was a Director in the Consumers Gas Company and was prominent in the management of the Bank of Toronto. He was a member of St. James Cathedral, Toronto, and the burial services were conducted by Rev. Canon Welsh. Interment was made in St. James Cemetery, the afternoon of December 27th.

C. W. PATTERSON, Burgess of Connellsville, Pa., has vetoed the ordinance granting the Star Gas Company the right to operate a gas plant in the place named.

MR. EDGAR T. POWERS, Secretary of the Consolidated Gas Company, Baltimore, Md., has been having trouble with certain bogus gas collectors. There should be no trouble on this account, because every employee of the Company whose duties call him into the premises of a gas user should be obliged to show the badge which entitles him to such entrance.

THE State Department of Philadelphia has granted a charter for the operation of a concern, known as the Peoples Gas Company, in Tamaqua, Pa., the incorporators of which are Messrs. George McDonald, of New York; Thomas Dunn, of Wilkes-Barre, and Philip Weill, of Tamaqua.

THE Philadelphia *Record*, of the 29th December, had this to say: "The local employees of the United Gas Improvement Company and its subsidiary concerns have started a beneficial organization. Upon the death of a member his widow or family receives $150 within three days of the demise. Although the society had been in existence only about three weeks, it has a membership of over 1,300 and applications are coming in rapidly. For the present members are assessed 25 cents per month, with a temporary additional 25 cents a month for the purpose of creating a fund for immediate emergencies. It is, however, explained by the finance committee that as soon as $1,500 shall have been placed in the treasury as a reserve fund the temporary assessment will be discontinued. The first call for a benefit was issued Christmas day, when a member died. The treasurer paid to the widow the $150 she was entitled to yesterday. The deceased had paid only 25 cents to the treasurer. The officers of the United Gas Improvement Company Beneficial Association are: C. A. Conrad, President; Elmer Smalling, Vice-President; R. A. Clanton, Secretary; and C F. Grimm, Treasurer. It is thought that within 6 months the association will have enrolled more than 3,000 members."

Mr. Lavery Bradley, President of the Atlantic City (N.J.) Gas and Water Company, has issued the following notice: "The Atlantic Gas and Water Company wishes to announce to its consumers that, commencing January 1st, 1905, the price of gas will be reduced to one dollar and ten cents, ($1.10), per 1,000 cubic feet. This rate is NET, and is not subject to any discount, and applies to gas used either for light or fuel. Ten days will be allowed for payment of bills at the office of the Company, and on all bills not paid within 10 days from date of bill a penalty of 5 per cent. of the amount of the bill will be added, and the gas will be turned off. In cases where two separate meters are now used one meter of sufficient size will be installed through which all gas will be supplied. Under the new price, this city will enjoy a gas rate as low or lower than any other city in the country with the same total consumption of gas, and of the same size as Atlantic City."

THE Milwaukee Gas Light Company, as a Christmas present to its worthy employees, is said to have given them a bonus amounting to 6 per cent. of the salaries earned by them in the past twelvemonth.

WE understand that Messrs. W. J. Logan and Frank J. Logan, of Brooklyn, N. Y., and associates, have become interested in the project for placing a gas plant in Babylon, L. I If Long Island's handsomest summering spot is looking for a gas plant the Logans are quite up to letting them have the right kind.

THE annual meeting of the Houston (Tex) Gas Light Company will be held in Houston at 10 A.M., the 14th inst.

THE Louisville (Ky.) Gas Light Company has declared the regular semi-annual dividehd of 3 per cent. The past year was the most prosperous one in the Company's history. It pays to do work well.

SINCE the 1st inst. the Milwaukee Gas Light Company is handling its coke for the market, having absorbed the business of the Metropolitan Coke Company. Col. Pratt deserves credit for putting an end to that go-between.

LET us hope that our latest prediction in this instance will come true. Ocean Grove, N. J., will have a gas supply next summer.

MR. H L. MCKEE, who recently retired from the service of the Meridian (Miss.) Gas Light Company, is said to be interested in a project for the establishment of a gas plant at Hattiesburg, Miss.

The Market for Gas Securities.

The continued energetic, if not diplomatic, assaults on the lighting properties controlled by the Consolidated Gas Company in and about New York and Westchester, and possibly Queens counties, had the effect of sending the price of Consolidated close to 195, and, in fact, the recovery to-day (Friday) to 196 to 196¼, was merely the result of some traders taking a chance to make their "half-points" good. The amazing thing in connection with this lighting problem is the "masterly retreat" made by "Little Mac's" son. He was right when he signed the Remsen bill, as the dictates of the highest legal appeal in New York will prove within a quarter year, and having stood to his guns then, why not maintain the faith? It looks that the Mayor is the husband of his wife. The output of gas by the Consolidated Company in December and January broke all records.

Brooklyn Union is featureless. Nominally it is offered at 210. Laclede preferred is showing signs of healthy improvement; Peoples, of Chicago, is well held; Washington (D. C.) is 320 to 322½, and 50 is bid for Gas and Electric, of Bergen County, N. J.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 Wall Street, New York City.

January 9.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$78,177,000	100	196	196¼
Central Union, Bonds, 5's	3,000,000	1,000	108½	110
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	3,300,000	1,000	118	120
Mutual	3,500,000	100	300	320
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. .. Bonds, 5's	11,000,000	1,000	112	113½
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	35	..
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	..	..	..
Northern Union, Bonds, 5's.	1,250,000	1,000	104	106
New York and East River.. Bonds 1st 5's	3,500,000	1,000	112	114
" 1st Con. 5's	1,500,000	..	106½	108½
Standard	5,000,000	100	125	130
Preferred	5,000,000	100	145	155
Bonds, 1st Mortgage, 5's	1,500,000	1,000	116	117
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	2 03	210
" " Bonds (5's)	15 000,000	1,000	113	115
Bay State	50,000,000	50	—	—
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works..	450,000	100	28	30
" 1st Mtg. 5's	500,000	1,000	93	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	5¾
" " Bonds, 5's	5,250,000	1,000	66	68½
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas and Electric Co	29,500,000	100	107½	108
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	97½	99
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¼	89¼
Preferred	3,026,500	100	107¼	109
Consumers, Toronto	,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	85	86
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	880,000	1,000	89½	92
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	..	50
" Prior Lien 5's	5,603,000	1,000	99¼	100
Detroit Gas Co., 5's	351,000	1,000	75	75¼
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO.,
N. W. CORNER BROAD AND ARCH STS.,
PHILADELPHIA, PA., Dec. 14, 1904.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable Jan. 14th, 1905, to stockholders of record at the close of business, Dec. 31, 1904. Checks will be mailed.

1541-4 LEWIS LILLIE, Treasurer.

Position Wanted.

A thoroughly up-to date man, now general manager of gas company, the output of which has increased over 90 per cent. in less than four years, desires to affiliate himself with a gas company in a city of over 50,000 inhabitants, where there is an opportun ty of increasing the business.

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Desires position on the road. Has experience. Is energetic and hustling and can get the business for any good supply house. Best references. Address, "G.,"

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1543-tf Address, "T. W. B. F.," care this Journal.

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AN ALL-ROUND GAS MAN.

One who is able to get the best results at the works, and who is qualified to handle men.

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Ten thousand gallons coal tar for sale at a bargain, if purchased and removed at once.

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NO EXTRA LABOR OR OPERATING EXPENSES.

IMPROVED AMMONIA CONCENTRATOR.

About 100 in use. Write to

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Steel Cars for Industrial Railways,
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Skip Hoists,
Screw Conveyor,
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Retail and Wholesale Coal Pockets,

Locomotive Coal, Ashes & Sand Stations,
Vessel Loading & Unloading Machinery,
Belt Conveyors,
Coal and Ashes-Handling Machinery,
Reciprocating Conveyors,
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Chain,
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Sprocket and Traction Wheels.

The "Link Belt" part of our name does not suggest the above list, but does lead you to infer that our business depends solely upon the genuine "Ewart" and perhaps some other chains, and that when building Elevating and Conveying Machinery we adhere strictly to Chain.

We wish to correct the wrong impression that our descriptive name gives, and so state—

First. Chain represents the small end of our business.
Second. We are every day estimating on and furnishing work in the above and kindred lines.
Third. We have a thoroughly well equipped wrought and structural steel department.
Fourth. There is no universal elevator or conveyor, and we furnish that which best solves the problem presented.

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IN AND ABOUT A GAS WORKS.

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The Company is ready to furnish testimonials as to the stability of the paint from gas men who have used it. Lists, tests and samples on application, for trial.

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This Company has purchased the patents and goodwill in the business hitherto carried on and owned by *A. M. Sutherland.* It is now ready to contract for the erection and installation of

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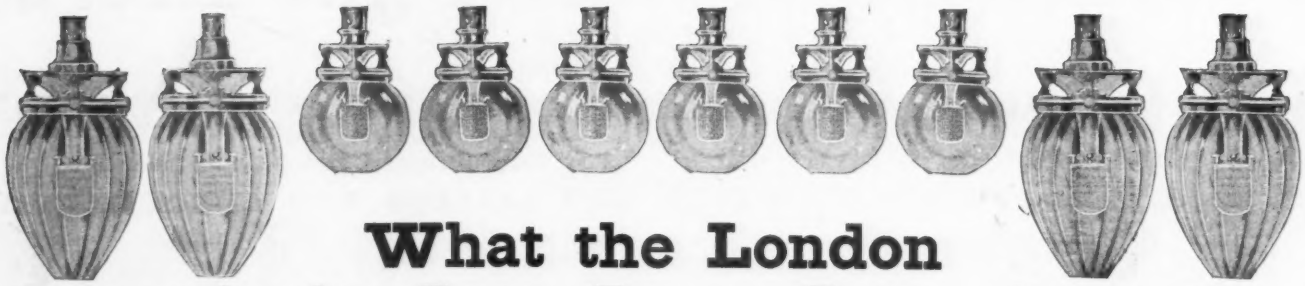

What the London *Lancet* in its Last Issue Says about that

NEW INVERTED INCANDESCENT GAS LAMP!

"Gas lighting by modern methods of high pressure incandescence, *inverted burners*, and so forth, threatens to outstrip *electricity* for general lighting purposes. This is no exaggeration when we reflect that invariably the finest streets in the great cities of Europe are now lighted with incandescent gas burners."

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The products of combustion are entirely separate from the water. Entire water surfaces are tinned.

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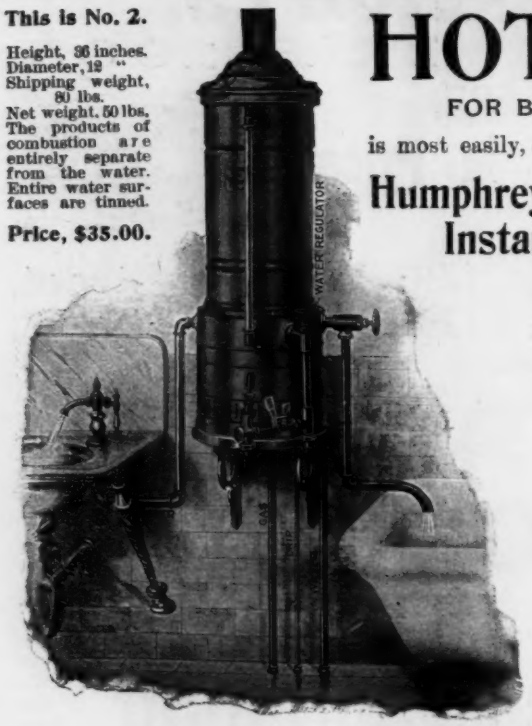

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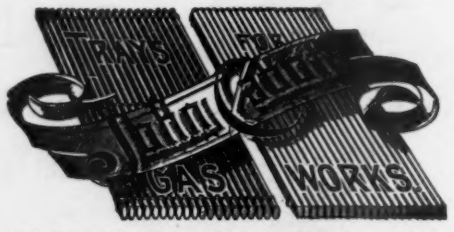

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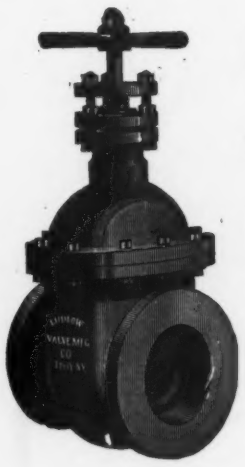

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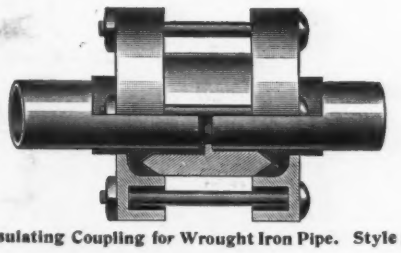

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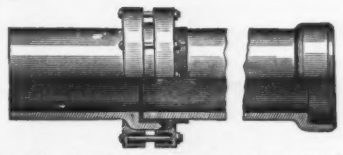

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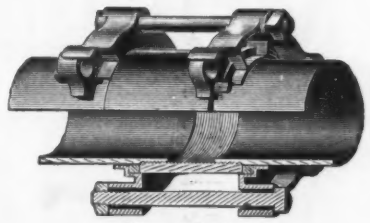
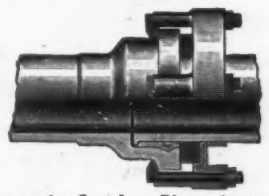


Clamp. Style 4.



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My Insulating Coupling prevents the destruction of pipe by electrolytic action, in either water or gas lines.

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3

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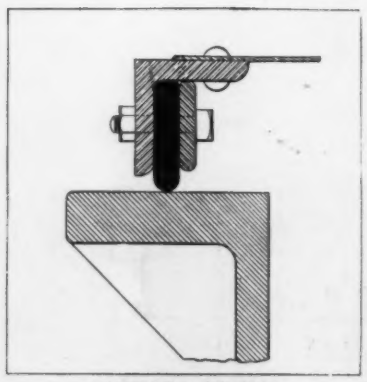

Patented Nov. 8th, 1904.

being rigidly held, does not depend upon either its own elasticity in a groove nor upon an adhesive substance to keep it in place, and

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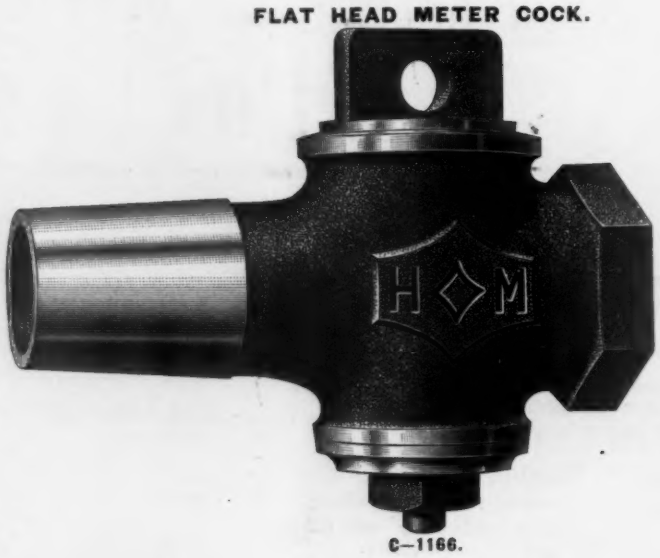

C—1166.

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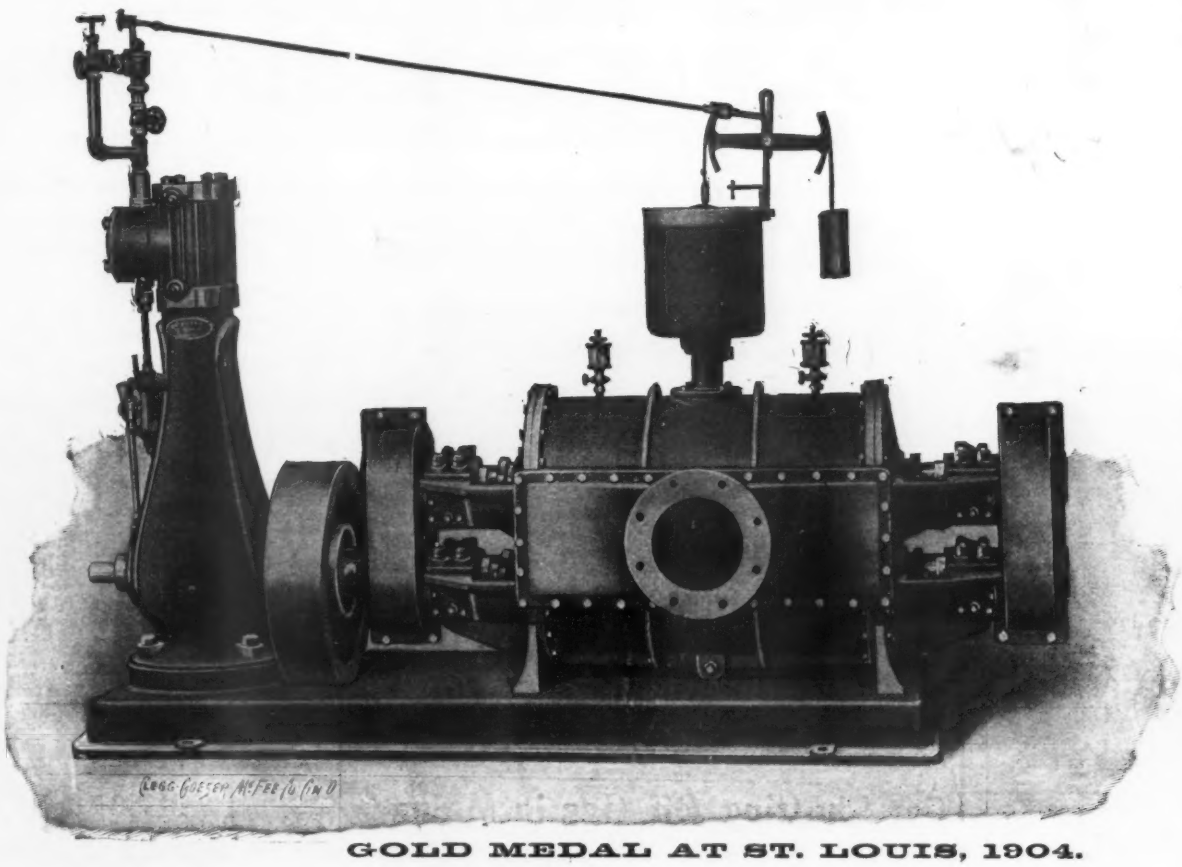

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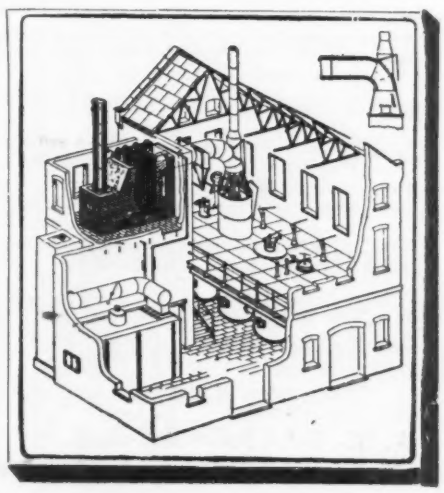

Do you know That in plants where it has already been installed the saving in fuel has been as high as 25 per cent.

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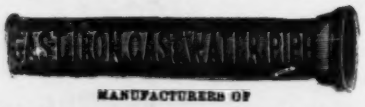

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Also, FLANGE PIPE, LAMP POSTS, Etc.

GAS TAPPING MACHINES

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Drilling and Tapping Pipe under Pressure

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Size of Combination Drills and Taps ¾ to 4-inch.

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Builders of UP-TO-DATE Machinery and Appliances for Coal and Water Gas Plants. :: :: :: :: ::

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SPECIFICATIONS
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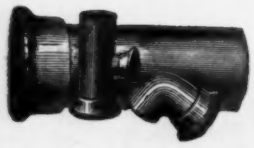

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FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

NO LEAKY JOINTS IN **UNIVERSAL PIPE.**

Specially adaptable for—
High and Low Pressure Gas Mains.
High and Low Pressure Water Mains.

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Any size gas main can be shut off in 30 seconds. : : :

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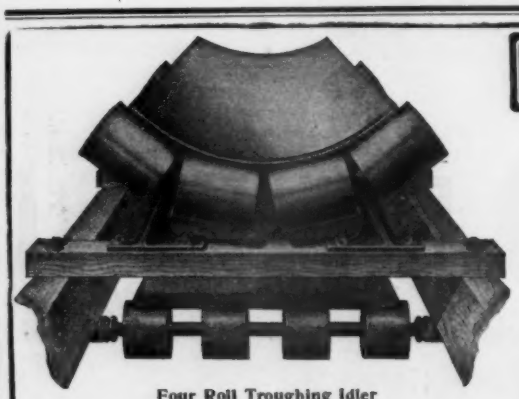

Four Roll Troughing Idler
FOR WIDE BELTS.
The positions of the rolls conform to a natural and uniform curve of the belt.

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EQUIPPED WITH

BALL BEARING ROLLS

Possess greater efficiency, consume less power, and the belts last much longer than when any other type of roll is employed.

Permit us to tell you why and to submit plans and estimates.

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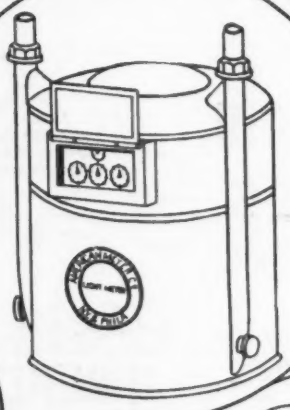
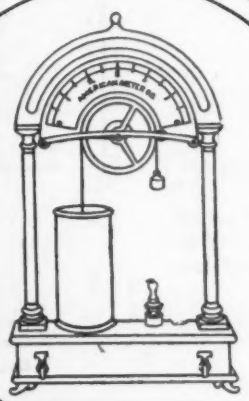
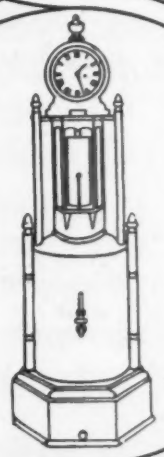
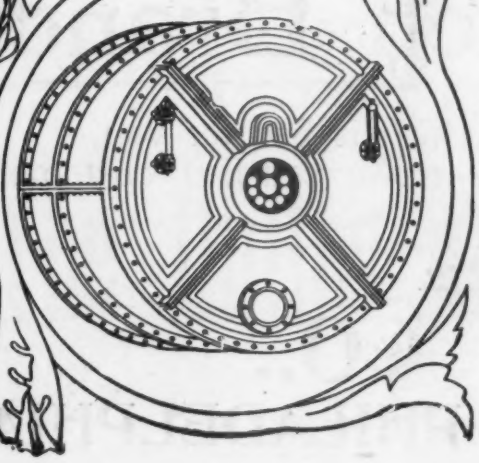




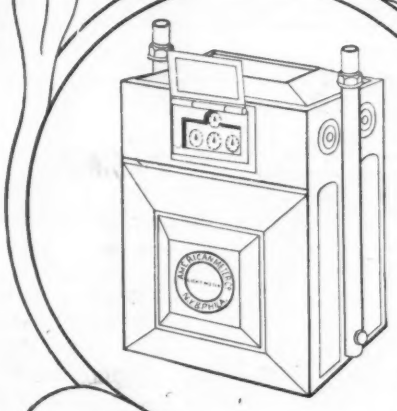


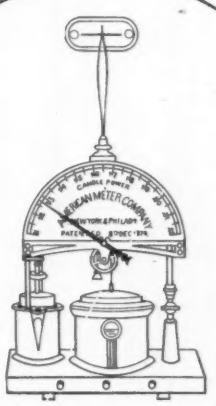


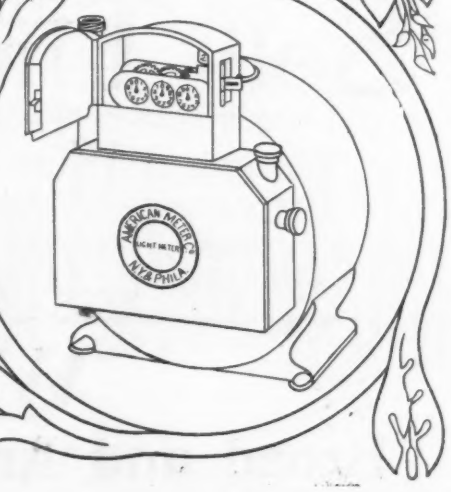
PUBLIC LIGHTING TABLE.

JANUARY, 1905

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sun.	1	5.20 PM	5.00 AM	4.30	6.30
Mon.	2	5.20	6.20	4.30	6.30
Tue.	3	5.20	6.20	4.30	6.30
Wed.	4	5.20	6.20	4.30	6.30
Thu.	5	5.20 NM	6.20	4.30	6.30
Fri.	6	5.20	6.20	4.30	6.30
Sat.	7	5.20	6.20	4.30	6.30
Sun.	8	5.20	6.20	4.40	6.30
Mon.	9	5.20	6.20	4.40	6.30
Tue.	10	8.50	6.20	4.40	6.30
Wed.	11	9.50	6.20	4.40	6.30
Thu.	12	10.40	6.20	4.40	6.30
Fri.	13	11.40 FQ	6.20	4.40	6.30
Sat.	14	12.40 AM	6.20	4.40	6.30
Sun	15	1.40	6.20	4.50	6.25
Mon.	16	2.30	6.20	4.50	6.25
Tue.	17	3.30	6.20	4.50	6.25
Wed.	18	4.30	6.20	4.50	6.25
Thu.	19	No L.	No L.	4.50	6.25
Fri.	20	No L. FM	No L.	4.50	6.25
Sat.	21	No L.	No L.	4.50	6.25
Sun.	22	5.40 PM	8.00 PM	5.00	6.25
Mon.	23	5.40	9.10	5.00	6.25
Tue.	24	5.40	10.20	5.00	6.25
Wed.	25	5.40	11.30	5.00	6.25
Thu.	26	5.40	12.40 AM	5.00	6.25
Fri.	27	5.40 LQ	1.50	5.00	6.25
Sat.	28	5.40	2.50	5.00	6.25
Sun.	29	5.50	3.50	5.05	6.15
Mon.	30	5.50	4.50	5.05	6.15
Tue.	31	5.50	6.10	5.05	6.15







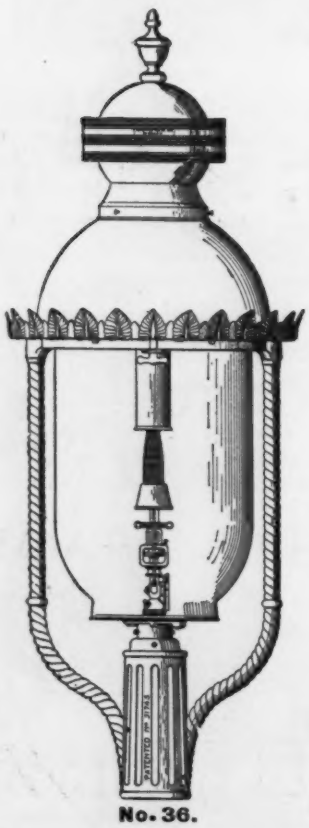
TOTAL HOURS LIGHTING DURING 1905.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	240.50	January	423.20
February	192.20	February	355.25
March	207.00	March	355.35
April	175.10	April	298.50
May	161.00	May	264.50
June	139.50	June	234.25
July	149.00	July	243.45
August	161.50	August	280.25
September	173.00	September	321.15
October	205.00	October	374.30
November	211.00	November	401.40
December	229.00	December	433.45
Total, yr.	2245.00	Total, yr.	3987.45

NEW YORK, 97 Liberty Street. BOSTON. 814 Beacon Building. PHILADELPHIA, Broad and Arch Streets. ST. LOUIS, 712 Roe Building. CHICAGO, Foot of Orleans Street. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....



No. 36.

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Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

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IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others interested in Municipal and Outside Lighting.

No. 38.

AN underlying principle in business is to show an increase each year---to grow. The astute dealer not only seeks to retain this year's customers, but to attract new trade next year.

The formula is simple---

THIS SHIELD IS THE WELSBACH TRADE MARK.

IT IS A GUARANTEE AND A PROTECTION.

Sell The Welsbach Brands.

The imitation stuff is bad for the customer---which is bad for you.

The genuine Welsbachs---Burners or Mantles---make satisfied customers---keep customers---MAKE NEW ONES.

And your profit isn't merely dollars and cents.

WELSBACH CO.,

Broad and Arch Sts., PHILADELPHIA.

THE UNITED GAS IMPROVEMENT COMPANY

For the Period Ending July 31st, 1904, has been Awarded Contracts in the Following Places for

Standard Double-Superheater Lowe Water Gas Apparatus.

Augusta, Me.
Bangor, Pa.
Woonsocket, R. I. (2d contract).
Brooklyn, N. Y. (4th contract).
Cincinnati, O. (2d contract).
Scranton, Pa. (3d contract).
New York City (14th contract).
New Haven Conn. (2d contract).
Watertown, N. Y.
Tampa, Fla. (3d contract).
Westchester, N. Y. (3d contract).
Bridgeport, Conn. (2d contract).
St. Paul, Minn. (2d contract).
Harrisburg, Pa.
Pelham, N. Y.
Reading, Pa.
Springfield, Mass. (2d contract).
Lynn, Mass. (5th contract).

TOTAL SETS, 1904, ... 35
TOTAL DAILY CAPACITY, 1904, . . 50,400,000 cubic feet.
TOTAL SETS TO DATE, ... 543
TOTAL DAILY CAPACITY, . . . 413,180,000 cubic feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
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RETORT SETTINGS

Water Gas Cupola Linings, Fire Clay, Etc.

Proprietors for the U. S., Coze System of Inclined Benches.

Estimates Furnished on Application for Most Successful Style of Construction.

Also for Free-Firing and Full and Half-Depth Regenerative Benches, for Burning either Coal or Coke in the Furnaces.

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Modern Coal Gas Plants,

With either Horizontal, Inclined or Vertical Retorts.

PATENTS APPLIED FOR.

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RETORT WORKS

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Fire Brick, Tiles, Etc.

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Our Improved Half and Full Depth Benches have been Adopted by Many Gas Companies.

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JOHN DELL,
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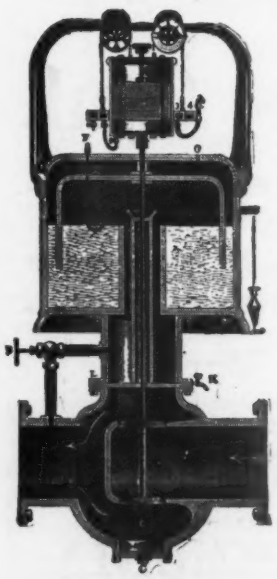

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TO DEMONSTRATE THE SUPERIORITY
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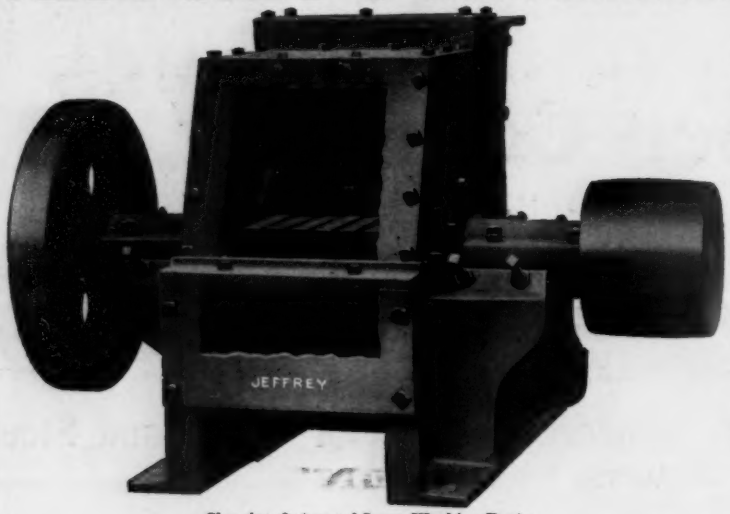

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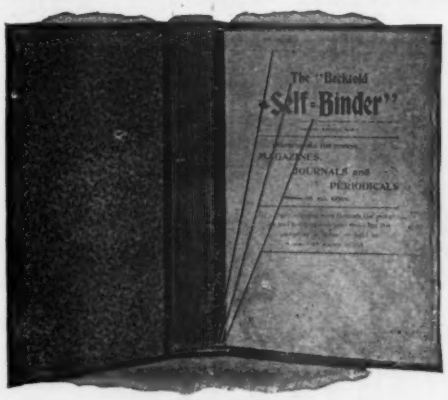

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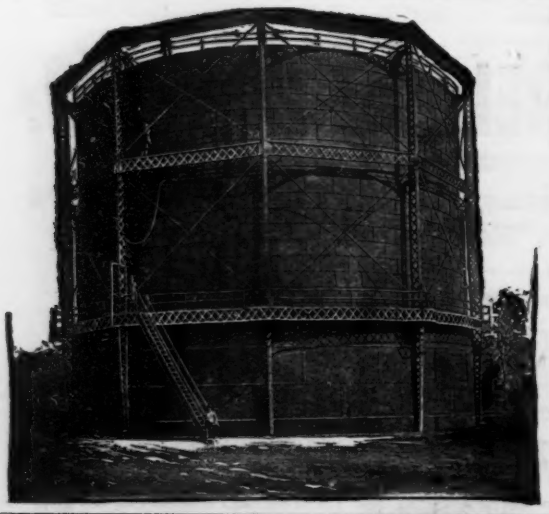

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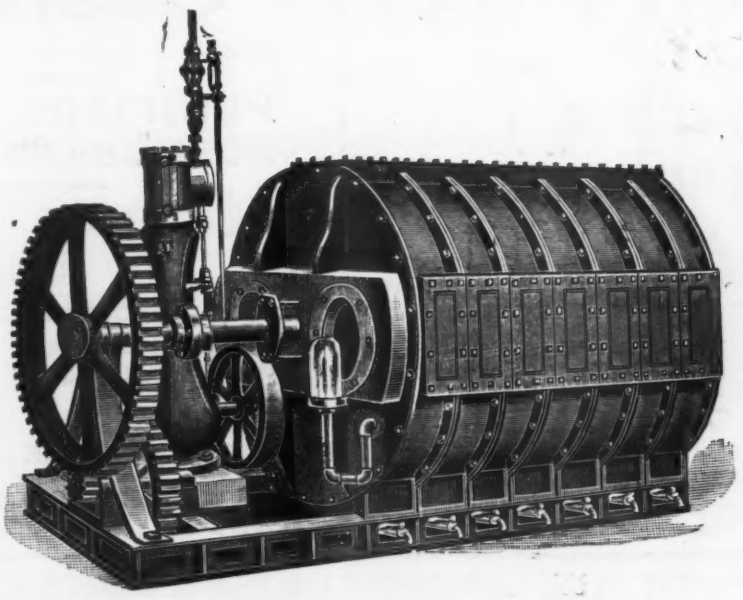

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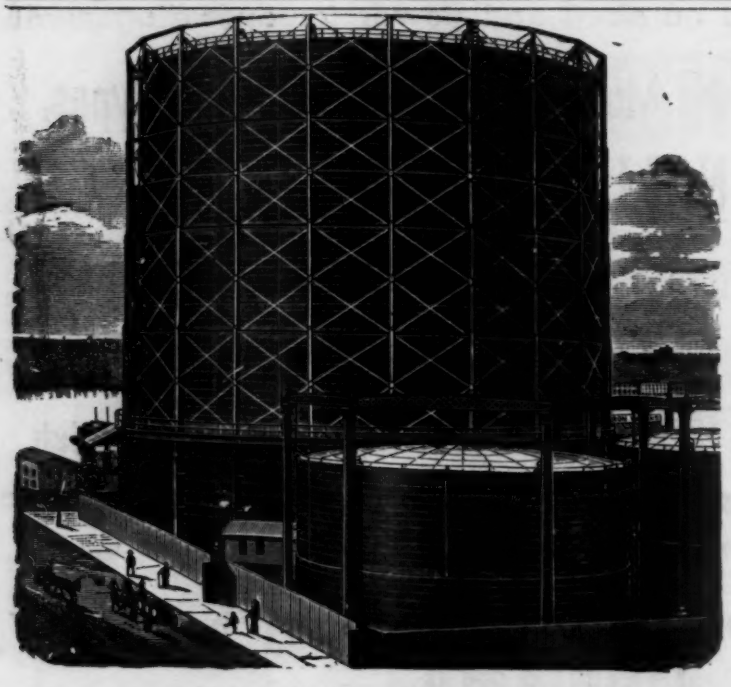

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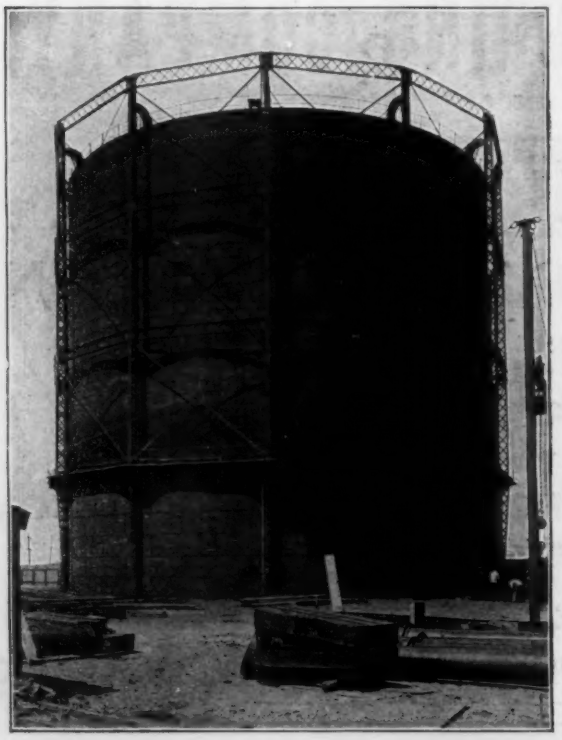

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